The Thesis Committee for Warner Lorraine Cook
Certifies that this is the approved version of the following thesis:

Breaking the Cycle of Municipal Solid Waste Management in the United States: A Contemporary Biotechnic Approach

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor: ______________________________
Robert F. Young

Co-Supervisor: ______________________________
Steven A. Moore

Breaking the Cycle of Municipal Solid Waste Management in the United States: A Contemporary Biotechnic Approach

by

Warner Lorraine Cook

Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degrees of

Master of Science in Community and Regional Planning

And

Master of Science in Sustainable Design

The University of Texas at Austin

December 2017

Dedication

With love and endless gratitude to my parents, sister, and partner for their boundless love.

Acknowledgements

I am indebted first and foremost my two advisors, Rob Young and Steven Moore. I had the chance to meet with each of you before I chose UT—I left both meetings knowing that I wanted to learn as much as I could from you. I had the opportunity to do so in multiple classes, and it was there that the ideas for this project were created and cemented. You each hired me, and put up with my tendency of polishing everything until the very last minute. Even after that, you agreed to be my thesis advisors, and provided me with immeasurable guidance, criticism, and praise. Rob, your belief that I could tackle such ambitious projects has helped me build my own confidence as a scholar. Steven, your assistance in developing my own process of writing have kept me on track and will continue to serve me for the rest of my career. You have both been excellent mentors.

I would also like to extend sincere gratitude to others who have taken an interest in my work and offered their advice along the way. Bjørn Sletto, Andrea Roberts, Michael Holleran, and Rachael Rawlins all inspired some portion of this project. Sarah Gamble gave me my first job in solid waste management, sorting through and cataloging studio waste, and if it were not for her I may have never written this thesis. Chelsea Cowley and Eric Hepburn let me continue developing my interest in resource management under their supervision. Thank you all for lending your time and expertise—it has meant so much to me.

Abstract

Breaking the Cycle of Municipal Solid Waste Management in the United States: A Contemporary Biotechnic Approach

Warner Lorraine Cook, MSCRP and MSSD

The University of Texas at Austin, 2017

Supervisor: Robert F. Young

Co-Supervisor: Steven A. Moore

Solid waste management in the United States is one urban practice that provides evidence for, and reinforces Marx's theory of urban "metabolic rift." However, urban planners as a field have historically shifted the onus for solid waste issues to engineers and private citizens. By avoiding waste, planners have dismissed a basic portion of their responsibility to the public and violated their own code of ethics. Repairing the metabolic balance of cities is admittedly a colossal undertaking. It will be necessary for planners to once again pay attention to the sub-field that spawned their profession, but this time through an updated frame, or mode of interpreting reality.

In the course of this project, I uncover frames that have been employed by planners in the past and the effects these frames have had for solid waste management. Finding that *rational positivist*, *grassroots communitarian,* and *insurgent radical* frames have not adequately addressed the chronic symptoms of our metabolic rift, I analyze and adapt a frame for planning, the biotechnic frame, which is based on Sir Patrick Geddes' theory of technics and civics. Finally, in order to test an innovative sustainable solid waste management technology that holds promise for repairing the metabolic rift, I evaluate the practice of landfill mining to determine whether or not it fits within a biotechnic frame.

This study shows that waste is a frame, or mode of understanding conditions, not an inevitability. Rather than solid waste sitting untouched in landfills, it can be reintegrated into the material and energy flows of the city-region, helping to balance the urban metabolism and "close the loop" on a historically linear waste cycle. With the appropriate frame, planners are especially equipped to facilitate this change.

Table of Contents

List of Tables

List of Figures

CHAPTER 1: PREAMBLE AND PROBLEM DEFINTION

Solid waste is dirty, sticky, smelly, sometimes hazardous, and certainly not glamorous; as such, many planners never consider the material consumption and waste storage systems of our cities. Waste is also (currently) a fundamental part of modern society. By avoiding waste, planners have dismissed a basic portion of their responsibility to the public, in effect resigning themselves to its inevitability.

Waste increases slowly and incrementally. We tend to "hide" it from ourselves on the outskirts of communities, but it leaves a permanent and stationary presence in our landscape. These unique characteristics contribute to a collective attitude that waste management is not an immediately pressing problem, both among planners and the general public. However, solid waste landfills pose significant public health and safety risks in the form of greenhouse gas emissions and hazardous leachate. If planners are to truly serve the public welfare, ignoring such urgent concerns is not an option. As the Ethics Code of the American Institute of City Planners (2016) states

> "Our primary obligation is to *serve the public interest*... We shall have special concern for the *long-range consequences of present actions*...We shall pay special attention to the *interrelatedness of decisions*... We shall *seek social justice*... We shall promote excellence of design and endeavor to *conserve and preserve* the integrity and heritage of *the natural and built environment*" (section A1; emphasis my own).

Ignoring solid waste planning does not serve the public interest and the focus of current “solutions” such as landfills or even the classification of spent materials as “waste,” is short-term and does not consider the complex interrelations of decisions or further social equity planning. Planning as a field must decide to accept its full responsibility, as evidenced in its own code of ethics, for solid waste, and the resources so labeled, as it has for transportation, housing, economic development, and many other specializations.

I and others argue that waste is not inevitable. Rather, following from Goffman (1986), waste and wastefulness is a frame, or a set of “principles of organization” which govern our definitions of situations and our participation in them (10-11). Alternative frames that define waste as a resource are possible and desirable in the face of the serious risks the predominant frame poses. In order to develop innovations beyond current practices of recycling, composting, and waste-to-energy technologies, planners must actively work to change our frames regarding both what problems we are obliged to address and what we define as waste and resource. Below, I make the case for the relevance of studying solid waste management and discuss the current landscape of practice.

1.1: A Declaration on Separation: Why Examine Municipal Solid Waste Management?

There are several statistics that planners and designers are likely to be familiar with in regard to anthropocentric effects on the environment, such as that buildings consume “nearly half of the energy produced in the United States” or that the transportation sector accounts for fourteen percent of greenhouse gas emissions (GHGs) globally (Architecture 2030, 2017; Pachauri, et al. 2014). Buildings and transportation are obvious targets for the environmentally minded planner to implement sustainable strategies. Unfortunately, because planners and designers have remained largely outside discussions of municipal solid waste (MSW) management, they remain unaware of the importance of addressing our current disposal systems. Municipal solid waste is defined by the U.S. Environmental Protection Agency as “durable goods, nondurable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes” and “come[s] from residential, commercial, institutional, and industrial sources” (EPA 1995, 17). The purpose of this section is to demonstrate the relevance and importance of studying planning frames for municipal solid waste management, by outlining specific environmental risks posed by landfills and outlining the way MSW management generally functions in the U.S. today.

Climate change poses a serious threat to our planet, and experts with the Intergovernmental Panel on Climate Change announced in 2014 that "human drivers...are extremely likely to have been the dominant cause of the observed warming since the mid-20th century" (Pachauri, et al. 2014, 4). Methane (CH_4) emissions exacerbate climate change by trapping radiation in the earth's atmosphere and raising global temperatures; methane traps radiation twenty-five times more efficiently than carbon dioxide (CO_2), the GHG with the greatest amount of emissions today (EPA 2017). Landfills produce methane gas through a process of oxidation, which occurs in the anaerobic layer known as the "zone of methanogensis" (Bogner, et al. 1995, 4119-4120). Overall, methane emissions represent ten percent of GHG emissions, and landfills are responsible for 17.6% of all U.S. methane emissions (EPA 2017, ES-23). Clearly, landfills exacerbate climate change through greenhouse gas emissions. Unlike other large contributors, such as fuel combustion and industrial production processes, landfills are site-specific and site-dependent, fully within the jurisdiction and responsibility of local planners to address. The potential for methane emission reduction should place landfills squarely in the purview of planners working to mitigate the effects of climate change, especially since point sources of emissions have proved to be easier to regulate than non-point sources.

Leachate is another risk associated with landfills that is perhaps a more visible and immediate problem when it occurs. Leachate is created when rainwater seeps into a landfill and a series of physical, chemical, and biological processes transfer pollutants from the waste to percolating groundwater (Kjeldsen, et al. 2002). Landfill leachate can contaminate groundwater and surface water, especially a concern with historic landfills prior to regulations on liners (Kjeldsen, et al. 2002). Although liners significantly reduce the hazard of contamination from leachate, leachate collection systems and liners can spring leaks and fall victim to faulty design, construction, and maintenance just like any piece of capital infrastructure (Schrab, et al. 1993). Volatile organic compounds and low concentrations of hazard chemicals, pesticides, and solvents are found in leachate and the effects of landfill leachate on our water system is still not fully understood (Schrab, et al. 1993). However, when failures do occur, the results can be devastating and planners should not be oblivious to the risk landfills pose to drinking water resources already growing scarcer each year.

An extreme example of risk that landfills pose to community health and safety is the underground fire burning beneath a landfill in St. Louis County, Missouri. Bridgeton Landfill has a subterranean fire of unknown cause that has been smoldering since at least 2010 and just 1,000 feet away lies the West Lake Landfill, a site contaminated by illegally dumped radioactive uranium in the 1970s

(Chicago Tribune 2015). While the West Lake Landfill has been designated a Superfund Site by the Environmental Protection Agency (EPA) since 1990, the decision to opt for containment rather than removal means that undetermined concentrations of nuclear waste are less than a quarter of a mile from coming in contact with a fire burning at over 300 degrees Fahrenheit (Schuessler 2015). If the two ever come into contact, sending radioactive smoke into the air, an unprecedented disaster would befall the residents and planners of St. Louis County and its metropolitan area. And, as if that is not enough, rates of rare cancers near the landfills have increased in recent years (Schuessler 2015). Hence, disaster and public health planners cannot ignore the potential for emergencies created by landfills and MSW management and have created an emergency response plan. This is an extreme case, but West Lake Landfill contrasts against chronic effects of landfills (climate change exacerbation) with very serious acute effects that are obviously within a planner's purview and responsibility.

While I have focused here on a public health argument for addressing landfills, there are other arguments to be made as well from the standpoint of equity and economic development planning. For example, it has been recognized for some time that landfills are disproportionately sited in proximity to low-income and minority (Ringquist 2005). Mohai and Saha (2007) have traced the causes of this phenomenon, finding that “factors uniquely associated with race, such as racial targeting, housing discrimination, or other race-related factors are associated with the location of the nation’s hazardous waste facilities” (343). Because I focus on public health in my above argument does not mean that these other related arguments are not equally as compelling. Suffice to say that the reasons for intervening in our current proliferation of landfills are numerous and cut to the core of many planning sub-fields.

Now that I have highlighted potential risks and hazards of landfills as relevant to many subsections of the planning field, I will summarize garbage in the United States today, to familiarize the planner that recognizes the need to take on MSW management in furtherance of public health and safety.

1.1.1: Where Are We Now? The State of Garbage Today

In 2014, the most recent year for which data is available, the U.S. generated approximately 258 million tons of municipal solid waste (EPA 2016). We landfill 136 million tons of waste each year in the U.S., or just over half (52.6%) of all MSW generated. Recycling and composting make up 34.6% of our waste disposal and 12.8% is incinerated for energy recovery. Per capita daily generation has held steady in recent years at about four and a half pounds per person per day generated, but increases in population are driving total MSW generation up nonetheless.

Of MSW generated, the largest contributions are from paper (26.6%), food (14.9%), yard trimmings (13.3%) and plastics (12.9%) (EPA 2016). As a country, we recycle much of our paper and compost a fair amount of yard waste, which results in the top discard into landfills being food waste. Significant strides have been made in recycling specific materials; for example, 98.9% of lead acid batteries disposed each year are properly recycled as are 89.5% of corrugated boxes. However, items that would seem to be second nature to recycle still only show moderate rates of recycling. Aluminum cans are only recycled at a rate just above half (55.1%), while glass and plastic containers are recycled at rates of only about a third (32.5% and 31.2%, respectively). It seems the push for recycling has not fully eliminated our solid waste problems as once expected.

So, where are the landfills that we send our MSW to in order to forget about it? Approximately 1,900 MSW landfills and 115 incinerators are in operation in the United States (van Haaren, et al. 2010). Rates of landfilling, recycling, composting, and incineration vary by region, with landfilling being utilized much less often in states in the West, Mid Atlantic, and New England regions than those in the Midwest, Mountain, Great Lakes, and South (van Haaren, et al. 2010). Regional variations such as this stem from space constraints or surpluses, since landfilling is the most spatially-intense of common disposal technologies. Tipping fees reflect this crunch on space. In areas where land is readily available such as Oklahoma and Texas cost per ton can range from fifteen to thirty dollars; in small, dense states like Vermont and New Hampshire tipping fees can easily exceed seventy-five dollars per ton disposed (van Haaren, et al. 2010).

Important to note, MSW is only a small portion of total waste generated each year. While an oft-cited rule of thumb says that categories other than municipal solid waste (e.g., medical, mining, manufacturing, agricultural) account for 97% of total waste generation, the truth is that this figure stems from data self-reported to the EPA by industries in 1985 and is therefore both out of date and potentially under-estimated (MacBride 2011). What is clear is that non-municipal solid waste generation in the U.S. is several orders of magnitude larger than MSW every year, and that most of it is held in private on-site facilities and thus difficult to objectively measure on a national scale.

1.1.2: Metabolic Rift in the Urban Metabolism

Kennedy, et al. (2007) define urban metabolism as "the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste" (44). The field (and term) has its roots in Karl Marx's *Capital* (1894), where he writes of the "conditions, which cause an incurable break in the interconnectedness of the social circulation of matter prescribed by the natural laws of life" (945). This idea, which has also been translated by other editors into English as a “metabolic rift,” has spawned a recent interest in urban metabolism studies (Foster 1999).

Originally a way for Marx to explain urbanization and industrial agriculture’s resultant soil degradation, the theory has been expanded to cover materials and energy flows generally within regions. In an ideal metabolism, every output of material and energy from one component of the system would function as a socially and ecologically beneficial input for another component of the system. However, as evidenced by the preponderance of landfills ringing urbanized areas today, our system has become linear rather than cyclical, characterized by plundering resource stocks of virgin materials and only returning back to the system a series of “emissions and final wastes” that are often toxic and modified to the point that they provide little or no value to the larger metabolic system (Brunner 2007, 12).

The relationship between urban areas and their hinterlands has become parasitic, disrupting the “return to the soil of its constituent elements” without returning anything of value back to the soil (or waters or air) (Marx 1867, 637). This leaves cities vulnerable, since they “depend completely on their hinterlands for both supply and disposal” of material (Brunner 2007, 12). It is, therefore, difficult to imagine a *sustainable* city that has failed to address its metabolic rift. A system plagued by inherent vulnerability cannot be fully sustainable—the two concepts are diametrically opposed as a system with too much risk has little chance of sustaining itself over the long-term. Thus, sustainable planning must reckon with the issues of solid waste management. Any work by planners to promote sustainable development and resilient communities is potentially jeopardized by the metabolic rift in urban regions until we begin to make substantial efforts at repairing this rift.

1.2: Research Questions

The research questions for my project stem from trying to find a way to navigate and repair the metabolic rift between our cities and material flows. To address this rift, it will be necessary to take first a historical perspective and second a theoretical one. We must know where we have come from to understand how we find ourselves in the current situation I have touched on above. Therefore, the first research question I propose for this project is the following:

Q1) What frames has the field of planning employed in MSW management?

I have chosen to examine the history of municipal solid waste management through the lens of frame analysis primarily because of my interest in sociotechnological systems and the "human factor" that is often overlooked in research studying waste management. All systems are necessarily both technical and social, and explicitly naming them as such is an attempt to highlight the often-overlooked social side. Sociotechnological systems are the sum of physical technical artifacts and software and the social "institutions, values, interest groups, classes, and political and economic forces" (Hughes 1994, 102) that are dependent upon one another to sustain a given technology. Put into the terminology of Patrick Geddes, every system is composed of both "technics" and "civics" that interact with and depend upon one another (Geddes 1915).

Through an historical approach, I hope to discern themes and categories of MSW frames that have dominated at various times (though I do not argue that frames will be entirely discreet from one another). The answer to research question Q1 naturally lead into a second, related research question:

> **Q2) Are there unintended consequences to the frames previously utilized that have contributed to our current MSW problem?**

By analyzing where previous and perhaps even current planning frames have created problems and failed to address the metabolic rift in U.S. cities, I hope to be able to sketch an outline of the things that have been missing from previous frames or that hold promise for reviving today. If frames or portions of frames can be mapped closely onto explicit current issues faced in MSW management, the hope is that a new frame can be synthesized that addresses most or all of the shortcomings without creating new or worse problems.

My final research question is as follows:

Q3) Can Geddes' biotechnic approach to planning provide an effective alternative frame for MSW management?

In this researching this question, I investigate how well a biotechnic approach frame fits against the sketched outline derived from answers to research question Q2. Too often humanitarians and social scientists seek to reinvent the wheel when proposing a new theoretical or methodological trajectory for their fields. "Hard" scientists often view their disciplines as entirely incrementally built, and as such naturally take for a starting point the ever-increasing base of knowledge created by others practicing science. In investigating Geddes' biotechnic approach as a basis for a new MSW frame, I hope to avoid this pitfall (and maintain a manageable scope of study) by building from the foundation set by planners before me.

1.3: Hypothesis: A Biotechnic Frame Provides a Path Forward

The purpose of this section is to state my hypothesis for each of my three research questions. For research question Q1, I expect to find several frames that have been in use over the course of MSW management in the United States, and to be able to define characteristics of each frame. Likely, these frames will not be discreet from one another or applicable during only one period of history. I hypothesize that a handful of frames will have developed and taken hold discipline-wide. Relatedly, I will say that I agree with other scholars (Goffman 1986; Tversky and Kahneman 1981; Brewer 2002; etc.) that frames are rarely consciously chosen by individuals and therefore while I will be looking for evidence of frames in the *practice* of planning, I will be attempting to be extrapolating backwards to define broad categories of frames useful for the *theory* of planning. Thus, I will be looking for patterns of traits that can be assembled into one of several general frames, understanding that in the process of clarifying I am also simplifying complex internal and individual decision making processes.

In regard to research question Q2, I hypothesize that once frames have been identified both shortcomings and benefits to each frame will become obvious via the frame's impact on our observable MSW outcomes. Finding the deficiencies of these frames should not be difficult, as in hindsight the oversights of the past can become exceedingly clear. I expect that identifying the proficiencies of each frame may be more difficult. Those frames that have proven themselves dominate over history have continued to hold sway precisely because of their successes; in this case, it can be difficult to understand the benefits as not inevitable.

Finally, for research question Q3 I hypothesize that a contemporary version of Geddes' biotechnic approach is the appropriate frame for planners to use when managing MSW into the future. Civics as Geddes realized it could provide the missing link to the attempted technics-focused solid waste management solutions that have failed to fundamentally change our production and consumption cycle and replace it with a new, non-waste frame. While I find a lot useful in Geddes' approach, I do hesitate to fully accept a theory that has not developed out of more recent practice. I believe that after applying biotechnics to a modern example of MSW management, I will discover it will need some adaptation in order to adequately and effectively guide practice in the twenty-first century. As I will discuss more in chapter 4, frames and methods already in use today have great similarity to Geddes' ideas. These contemporary analogs include the zero-waste movement, urban metabolism studies, and the circular economy.[1] Unifying these disparate sub-groups of planners around a common frame is likely what is needed to address our issues in solid waste management today.

1.4: Thesis Structure

This thesis, being primarily historical and theoretical in approach, will follow in a structure that will provide for many smaller findings and arguments along the way. But before I begin relaying findings, I must first explain my own research frame in order to be forthright. I will discuss my methodology and my methods in

[1] A "circular economy" is one that "aims to leave the dominant linear economic model" in favor of "a circular economic model that acknowledges a more environmentally sound bio-based and renewable resource use" (Johansson 2016, 2).

the next chapter (chapter 2). The next chapter (chapter 3) will cover my historical analysis of U.S. MSWM management in roughly chronological order. After addressing some critiques of the literature I have relied on, I will summarize the frames that I have found in answering research question Q1 and then summarize the themes that have emerged in answering research question Q2. I will detail Geddes' theory of technics and civics in chapter 4, and similarities between Geddesian theory and zero-waste. Chapter 5 will consist of a case study of landfill mining in order to help address research question Q3. I apply a biotechnic frame to the process of landfill mining and test to see if the frame "fits" the technology and MSW management needs. Chapter 6 will attempt to tie the findings of the thesis together and sketch the outline of a new frame for planners to focus practice towards in the future.

CHAPTER 2: METHODOLOGY AND METHODS TO BALANCE THE URBAN METABOLISM

The purpose of this chapter is to explicitly state and make transparent my methodological frame for research and the research methods I used. I will explain my own assumptions, how I intended to carry out a research agenda, why that agenda changed, and the methods I ultimately settled on.

2.1: Methodology

Especially for a research agenda concerned with uncovering frames and making their characteristics known and their effects explicitly stated, I would be remiss to not discuss my own methodological framework. My frame affects the types of questions I ask, the methods I choose to research those questions, the way in which I interpret the data I gather, and ultimately what conclusions and findings I deem relevant or not. In discussing my frame overtly, I hope to make clear my reasoning for the design of my research agenda, and to encourage other scholars to do the same.

2.1.1: Critical Pragmatism, Boundaries, Power Dynamics, and The Everyday

The investigation lends itself to a critical pragmatist set of assumptions. Critical pragmatists "view social action as the site where multiple realities are created...with an emphasis on the construction of reality as a struggle between conflicting discourses and competing definitions of the situation" (Vannini 2008, 160). This view towards social action aligns with Herbert Simon's (1988) tenet of design-reasoning in research that to design is to "[devise] courses of action aimed at changing existing situations into preferred ones" (67). Critical pragmatists, in the form of institutional ethnographers, "study how everyday experiences are shaped by relations of power generated within social institutions and typically transmitted through texts and discourses" and is also often concerned with the "formation of symbolic boundaries" (Vannini 2008, 161).

This focus on boundaries, power dynamics, and the everyday experience speaks to the research questions I have set for myself. Frames are themselves boundaries to the way that we perceive our circumstances, limiting what we can see. The frame we utilize clearly will determine how and what we view as undesirable circumstances, as well as what methods we consider available to change those circumstances. Because frames inform and are informed by system boundaries, a critical pragmatist research frame is useful for this thesis.

Additionally, civic decisions are fraught with uneven power dynamics, especially in infrastructure and service delivery where capital outlays inevitably enjoin municipalities to financial interests (Harvey 2000). Nearly no decision a planner can make will unilaterally have a net-positive effect for each person in a community. Even if each member of a particular community will benefit from a decision, the effects outside the system (in other communities) may not be fully positive, as will be discussed in the case of the legacy of environmental racism in MSW management decisions. A critical pragmatist frame attempts to acknowledge and probe these power dynamics, looking to suggest solutions that will enhance equity for those groups historically without power in public decision making (Forester 1989). A related and useful concept to understand equity with comes from philosopher John Rawls' (1971) construction of justice and his "difference principle," in which justice exists when

> "All social values—liberty and opportunity, income and wealth, and the bases of self-respect—are to be distributed equally unless an unequal distribution of any, or all, of these values is to every- one's advantage" (60).

In fact, because "low-income and minority communities in liberal democratic societies suffer a disproportionate burden of environmental hazards," a Rawlsian version of environmental justice can address these power imbalances and their physical outcomes especially well (Bell 2004, 287).

Finally, the importance of the "everyday" to critical pragmatists fits well with research on MSW management. Few things are so certain as birth, death, and waste generation. In the U.S. currently, waste generation is so everyday that in many ways it is invisible to the average community member and scholar. Henri Lefebvre, writing on the importance of studying and critiquing the everyday, argued that the complexity of modernity necessitated considered analysis of the everyday (1991). He writes that “rational, programmed abundance and planned obsolescence,” “omnipresent war and violence,” and “destructive colonization of the third world and finally of nature itself” are irrational realities disguised as rationality (Lefebvre 1987, 9). Therefore, it is the “everyday, established and consolidated” that “remains a sole surviving common sense referent and point of reference” (Lefebvre 1987, 9). Garbage is as everyday as it gets, and therefore we can expect studying it to help us understand complexity and “illuminate the past” (Lefebvre 1987, 10). The importance of “ordinary, everyday landscapes” is central to planning and the built environment; the vernacular and ubiquitous can tell us about selective and collective human histories and realities (Groth 1997, 1). Perhaps more ambitiously stated, reading the everyday landscape around us clues us into “our unwitting autobiography, reflecting our tastes, our values, our aspirations, and even our fears, in tangible, visible form” (Lewis 1979, 1). To understand planning frames, then, we must examine the familiar.

Considering waste management systems as sociotechnological systems, rather than simply technical systems, will inherently mean considering the actions and agency of people in the system and the knowledge and practices that maintain and change the system over time. Socio processes (and, therefore, technologies) are created and perpetuated in a complex information-network with specific circumstances and actors that result in specific constructed findings.

While some pragmatists such as James (1907) have argued that all reality claims are equally *true*, critical pragmatists have countered that all realities are not necessarily equally *just*, which is the more important concern. Pragmatism is often criticized by Critical Theorists as naively optimistic or as perpetuating the status quo of a U.S. democratic system, as ignoring the influence structures exert over individuals. Critical pragmatism begins to overcome some of these critiques by examining the pervasiveness of structural powers and the conflict of goals between different actors within sociotechnological systems. The critical portion of critical pragmatism can help begin to answer the issue of relativism in research, or the assertion that research is not valid if it is inapplicable in other contexts. A critical pragmatist study aims to discern patterns and processes within a complex and specific set of conditions and then offer a new constructed reality that can be put in dialectic with other realties elsewhere in an effort to affect social change. Above all else, I hope that my critical pragmatist research can contribute to increasing equity and justice; what follows is a description of the methods I planned and used in pursuit of this goal.

2.2: Methods

This project has evolved substantially since its initial conception, as most are wont to do, I imagine. I have chosen to include both my initially anticipated research agenda and my updated, or "as-built," research methods. My hope in doing so is that others who may either be embarking on a large-scale research project for the first time or considering extending my research themselves may have a clear picture of the planned route and the pitfalls I found along the way.

In the first sub-section (2.2.1), I will explain the initial strategy that I devised to answer those research questions. The following sub-section (2.2.2) will briefly detail what difficulties I encountered that resulted in changing my research questions and methods for the final version of this project. The last sub-section (2.2.3) will lay out the revised research agenda I created to answer the three research questions for my project (see section 1.2).

2.2.1: Original Research Agenda

When I first began, this project was focused on the "information ecology" of landfill mining. In other words, I planned to analyze how communication and knowledge surrounding the practice was transferred and utilized by those making MSW decisions. Therefore, my research questions were quite focused on information studies and seeking out specific answers with quantitative data. My initial research questions were:

> **I. How do decision makers within public waste management systems obtain, apply, and share information resources?**, and
>
> **II. How do these processes and sources differ between municipalities who employ enhanced landfill mining and those who do not?**

I planned to address these questions through empirical means, and looked to historical and theoretical methods to support and synthesize those empirical findings.

The primary strategy of this initial research was a comparative case study. The intent was to create a dialectic comparing two competing public sociotechnological waste management systems (one within the political and historical realities of Belgium and the other specifically within the realities of the United States. This comparison was not meant to result in research that suggested one system is objectively better than the other. Instead, the comparative case study, recognizing my own methodological assumptions, was meant to reveal value- and meaning-rich decisions and communication systems within waste management in different contexts in an effort to generate knowledge useful for constructing our collective realities moving forward.

The first method of data collection was to be archival research. The sources for data would include annual reports generated by municipalities (and perhaps states/provinces or nations if available and relevant), academic white papers written about the municipalities and landfill mining, publications/advertising materials/multi-media from Group Machiels, EURELCO papers and conference proceedings, and departmental organizational charts and policies. I planned to code these points of data using NVIVO software to find patterns that emerged between sources, as well as to note discrepancies that may be present between different sources. This stage of research would have informed later actor-network diagramming, and provide the basis for determining the professed flow of information and decision making processes. Archival research also highlights what current resources on enhanced landfill mining are easily accessible, and any meta-messages being pushed about what ELFM is and can do.

The second method of data collection for the original agenda was to conduct personal interviews of decision makers within the two public sociotechnological waste management systems. I planned to complete five 45-60 minute structured interviews with the stakeholders of each case study municipality. The interviews would have included both higher and lower ranking members of the organizations, as well as a member directly involved in finances/budgeting and a member directly involved with policy creation. I also built time into my proposed schedule to interview other key stakeholders that emerged through the initial interviews, a process known as snowball sampling or chain referral sampling.[2] Because it was my assumption that many of the actual decision makers within these systems may be hard to identify at the outset of research, snowball sampling as a technique would have ensured that my pool of interviewees represented a full range of actors in the systems. I planned to focus on ascertaining sources of information the agents look to for sustainable waste management practices, how information is shared among the parties, and how insights are published and disseminated to the wider waste community worldwide. I planned to also utilize NVIVO software to code and analyze the transcriptions of the interviews. I would have also mined the interviews for references to other agents/elements in the systems that could feed into later actor-network diagramming.

Pulling from both the archival research and interviews, the third data source would have been actor-network theory (ANT) diagrams. This method of analysis documents the knowledge-building and decision making processes in each case city's sociotechnological system. An actor-network diagram can help reveal

[2] Snowball sampling is a non-random sampling technique in which an identified participant refers other potential participants to the study, and so on (Vogt, 2005). It is especially useful for studies concerning populations that may be difficult to identify or are small in number and are likely to know one another.

nuance in a system, as well as the strength of relationships between actors and mutual influences. As Bruno Latour argues of ANT, the elements and outcomes include the following tenets:

> "the social as normally construed is bound together with already accepted participants called 'social actors' who are members of a 'society'; when the movement toward collection is resumed, it traces the social as associations through many non-social entities which might become participants later; if pursued systematically, this tracking may end up in a *shared definition of a common world*, what I have called a collective; but if there are no procedures to render it common, it may fail to be assembled" (Latour 2005, 247; emphasis my own).

This method of constructing a social system emphasizes the linkages between decision makers, the information sources, the applicable policies, and even the waste itself as a non-human actor. Examples of Actor-Network diagrams are included in Appendix A.

The final method of data collection and analysis I had planned for the original project was decision-tree analysis. Decision tree analysis is useful in modeling decisions that must be made in relation to anticipated consequences and uncertainty surrounding those outcomes. It is a method of using assigned probabilities for outcomes to determine the "optimal decision" based upon known or likely effects of particular sets of decisions (Sonnenberg and Hagerty 2009, 333). These known or likely consequences can either be represented by parameters of monetary values (costs) or utility to the system (value-added). Such analysis is helpful in aiding actors better understand the decisions they face based on their current knowledge, past likelihoods, and implicit valuation of parameters.

The process can also be iterative; as new information about likelihood, parameter values, and organizational values becomes available, the model will grow in sophistication. This is a quantitative way to build an institutional "memory bank" to aid in future decision making, and can also be used to help other municipalities who may be considering enhanced landfill mining for the first time. An example of a common decision-tree model previously created by myself for a different project is included as Appendix B.

Triangulation of data would have ensured that the research was robust. Triangulation "involves the utilization of a variety of data sources, multiple investigators, and/or a combination of data collection techniques in order to cross-check data and interpretations" (Groat and Wang 2013, 84). This was accounted for in my research agenda through the combination of the four methods outlined above. By collecting these distinct types of data, findings could be either corroborated or unsubstantiated between datasets to more accurately understand the communication processes within and between waste management systems. Triangulation as a method of data collection intends to prevent any potential bias in findings based upon a singular source of information or understandings of the system, thus overcoming the critique the that qualitative research is inapplicable to outside situations because it relies too heavily on imperfect human understandings of reality and a researcher's own subjective interpretation of data and findings. An additional benefit of triangulation is that it guards against staying fully within a single set of assumptions that may be successfully challenged by researchers working in a different research paradigm.

2.2.2: Why the Research Agenda Changed

There are several reasons led me to alter my research design. The first reason, which is probably obvious after the previous sub-section, is that the research agenda I outlined above is overly ambitious for a masters' thesis project. While I gave careful consideration to how much time it would take for me to conduct interviews and transcribe them, I did not consider how much time and effort locating interviewees would take beforehand. Without factoring in the difficulty of securing interviews, a research agenda based on interviews as a primary data source quickly became infeasible.

A second reason that I changed my research agenda was the reality of conducting international fieldwork. Through generous funding from the University of Texas at Austin School of Architecture's Leipziger Travel Fellowship Fund, I was able to conduct fieldwork in Belgium in August 2016. I traveled to the Remo Milieubeheer landfill, just northwest of Houthalen-Helchteren, the capital of Belgium's Limburg province. One of the major issues I encountered during my fieldwork was the differing work schedules in the country from the United States; I was informed when I arrived by a local that a majority of Belgium employees vacation during the month of August. With nearly everyone out of the offices, and difficulties of a language barrier in email messages, I was not able to conduct any interviews. Although I had thought I was set to tour the site of the landfill, when I arrived on that day I was actually denied access at the entrance and was only able to walk to perimeter of the fenced site. While all of these setbacks were extremely frustrating, I have to admit in hindsight that they seem obvious. Before this project, I had no international contacts in the solid waste management field, had never traveled out of the United States, had never conducted fieldwork on my own, and had only limited conversational Dutch language skills.

Upon my return and with the advice of my advisors, I shifted my focus from interviews to a survey instrument that I hoped would provide many of the same answers to the research questions I had concerning the information ecology of landfill mining. I spent the next few months developing and revising a survey protocol and securing permission from the university's Institutional Review Board (IRB). My plan was to disseminate the survey through email newsletters to European landfill managers belonging to various solid waste management organizations.[3] After reaching out to four organizations to gauge interest in partnering with me to publicize my survey to their members, I received agreement from two of the groups, EURELCO and ISWA. Over the five months the survey was open, I received only three responses, certainly not enough to utilize as the primary data source for my thesis project.[4] While preliminary findings will be drawn from these three responses in Chapter 5, I became aware after the first month resulted in only one response that I would need to take a step back and evaluate my project once more. It was at this point that I chose to substantially alter my research questions in order to bring the project to a close more quickly. Because I had already done extensive background literature reviews on both the history of solid waste management in the United States and on landfill mining, I was able to reformulate research questions that could be answered with that data, which was ready and available. The final version of my research agenda is detailed in the next sub-section.

[3] The four organizations I contacted were: 1) FEAD (Fédération Européenne des Activités de la Dépollution et de l'Environnement / European Federation of Waste Management and Environmental Services), 2) ACR+ (Association of Cities and Regions for sustainable Resource Management), 3) EURELCO (European Enhanced Landfill Mining Consortium), and 4) ISWA (The International Solid Waste Association).

[4] A total of 65 members belong to ISWA's Working Group on Landfills. An unknown number of potential respondents were contacted through EURELCO's email list and my project was posted to the organization's website. According to EURELCO's website, they currently have 58 member organizations in 13 different European countries.

2.2.3: Revised Research Agenda

The following section defines the methods that directly led to the final version of my thesis project, and argues for the relevance, robustness, and validity of the methods I have chosen. In lieu of empirical methods my research design has shifted to historical and theoretical methods.

As mentioned briefly above, through the course of this project I developed extensive "literature awareness," defined by Groat and Wang (2013) as having the goal "to identify...literature and become familiar with it" (143). Moving beyond awareness, I completed a literature review that "group[s] themes, synthesize[s] ideas, explain[s] different schools of thought, [and] trace[s] historical development of an idea or theory" (Groat and Wang 2013, 143). Because both of these stages of literature engagement are found in the majority of thesis projects, it might be difficult at first to untangle my primary method, historical research, from literature awareness and review. In practice, historical research is not easily distinguishable from conducting a literature review; the researcher spends the majority of their time reading primary and secondary sources and attempting to synthesize them. The difference, according to Groat and Wang, is that historical research requires "fact finding, fact evaluation, fact organization, and fact analysis" and requires the creation of a narrative that compellingly and imaginatively orders these facts without devolving into speculation or fiction (Groat and Wang 2013, 207). I engaged with the texts I read on this level, consistently re-ordering and re-categorizing facts as I sifted through evidence and evaluated the testimony. My evidence is within texts, both academic research and governmental reports, and the findings I will develop are based on patterns, relationships, and themes.

At the end of both Chapters 3 and 4, I have made attempts to synthesize this evidence into coherent, although not totalizing narratives. Of course, historians are easily targets of subjectivity critiques, as the decision which pieces of data to include and exclude from the constructed narrative is based upon the frame of the researcher themselves (Groat and Wang 2013, 210). Therefore, it is important to distinguish my own frame and tendencies regarding historical research and the project of historiography. I do not follow the positivists' vein that holds a "single history of the world [is] possible," (Groat and Wang 2013, 185) nor do I follow the modernists' in the tradition of Hegel and others who argue that "history is the ongoing evolution of a communal consciousness" where each individual is unknowingly enmeshed in this "zeitgeist" (Groat and Wang 2013, 187). I am swayed to an extent by the structuralists' arguments that both the *langue* (the grammar or rules) and *parole* (the actual actions of individuals) govern culture and that historical meaning is found "in the relation between things, rather than in things in isolation" (Barnard 2008, 181-182). However, following the poststructuralists, I feel "no obligation to a general sense of progress, or even necessarily to any sense of holistic communal identity" (Groat and Wang 2013, 193). Although a poststructuralist frame for historical research is not equipped to generalize a "universal or transcendental understanding of 'reality'" and history, it excels "in grasping the immanent knowledge operating in any particular cultural-temporal space" and does not shy away from density and complexity (Groat and Wang 2013, 192-193). Since my research topic covers multiple fields of study and my period of interest covers nearly two hundred years, I am confident that a frame that blends elements of structuralism and poststructuralism will be true to this complexity while still managing to draw transferrable conclusions

Historical research is predicated on multiple types of evidence; "determinative evidence," like dates, which "situates the object of study in a particular time and a particular place," are obvious, but other types of evidence such as contextual, inferential, and recollective evidence are also available to the historical researcher (Groat and Wang 2013, 195). Using "contextual" evidence, or cultural factors synchronic to the object of study, can provide additional insight into the object of study as well as increase the robustness and reliability of the argument (Groat and Wang 2013, 198). "Inferential" evidence links facts that by date or spatial proximity can be reasonably considered to be related (Groat and Wang 2013, 198). Finally, "recollective" evidence, primarily consisting of data sources such as oral histories and autobiographical writings, can be considered as long as the researcher is careful to account for the interviewee, the interviewee's credibility, and what can be corroborated with other types of evidence (Groat and Wang 2013, 201). My research project utilizes determinative, contextual, and inferential evidence to piece together planning frames on MSW management; utilizing multiple types of evidence adds to the complexity I hope to embrace and each type of evidence works to corroborate or challenge others. In a larger-scale version of this research, it would be highly beneficial to include more recollective evidence, especially through oral histories since much of written record is mediocre at best in its treatment of the everyday.

While Chapters 3 and 4 of my thesis are primarily concerned with historical research with the goal of naming and describing frames and themes, Chapter 5 on landfill mining uses a different tactic, the case study. Yin (2009) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context" (18). A case study of landfill mining as a method of research inquiry is especially apropos as it involves "studying a case in relation to the complex dynamics with which it intersects and from which the case itself is inseparable" (Groat and Wang 2013, 421). Landfill mining as a process cannot be easily extracted from its context, as many contextual factors from policy incentives to cultural values to prices for other methods of disposal are always shaping the practice of LFM in a dialogue.

My case study is both “exploratory” and “explanatory” in form and has the goal of theory development. It is exploratory in that I am attempting to look closely to see, as Jane Jacobs said, “whether any threads of principle emerge” as a “way to get at what goes on” (Jacobs 1961, 13). It is explanatory in that in attempts “to explain the underlying order” of MSW management in the United States in a way that is useful to furthering praxis (Jacobs 1961, 15). Case studies derive part of their strength from using multiple sources of evidence in order to generalize theory from their particular objects of study, and my research findings on landfill mining’s “fit” within a biotechnic frame aim to develop and test a theory for future waste management practice. Although a case study has the potential for “overcomplication” and the challenge of creating coherence from multiple data sources, I feel the strengths of a case study’s richness and embeddedness outweigh these weaknesses (Groat and Wang 2013, 441). Because planning is by definition a multidisciplinary field, I agree with Groat and Wang that combining historical research with a case study has the potential to offer important insights to our solid waste management practice moving forward. My shift from empirical methods to historical and theoretical ones will serve the new research questions I have developed, and provide the basis necessary for future research into specific sustainable waste management innovations and, more generally, the practice of sustainable waste management.

CHAPTER 3: AN OVERVIEW OF MUNICIPAL SOLID WASTE MANAGEMENT FRAME IN THE UNITED STATES

Planning's relationship to waste and waste management has a varied history, almost cyclical in nature. Planning as a field of expertise (at least formal planning in terms of the profession) began in Europe and the United States in the late nineteenth and early twentieth century as a response to a crisis of waste management. The efficiency with which planners were able to mitigate this problem both granted the profession legitimacy and resulted in the abdication of this domain leaving its management primarily to civil engineers. As I will show, planners in effect believed that they had "solved" the issue of MSW management, a belief that was supported by planning frames that define urban issues as capable of being completely fixed.

A resurgence of waste management concerns in the 1960s and 70s brought the issue back into the sphere of planning to an extent, forcing existing technologies and practices to conform to specific technological and legislative thresholds set by regulations. Since then, however, planners have once again let the issue of waste management slip out of the system boundaries it prescribes for itself. I argue that planning must redefine its boundaries to fully encapsulate waste management as a concern; more strongly, I assert that, rather than waste management, the complete cycle of production, use, and consumption be fully integrated into the profession as a problem both worthy of addressing and of the most critical importance.

Throughout this chapter I will rely on the most prolific scholar of infrastructure and waste history in the United States, Martin V. Melosi, though many other critical portions of history, as I will show, were missed or undeveloped in his work. These criticisms will be addressed together towards the end of this chapter in section 2.8.

3.1: The Public Health Paradigm Gives Rise to Sanitary Planning

The history of municipal solid waste management in the United States begins before what we typically view as the beginning of planning. Sanitary planning, a field less comprehensive than city planning, found its start in the budding field of public health even before the U.S. Civil War of the 1860s. In this section I will trace the beginnings of public health through sanitation planning until the City Beautiful Movement in order to better understand the scientific battles being waged over poverty, miasmas, and germs.

As Louis (2004) explains, waste and especially organic litter, has been dumped by humans from the beginning of recorded history. During the Colonial Era, U.S. cities "suffered from poor sanitation and an absence of waste management services," with wastes dumped on open land, buried, burned in the home, or rejected into water bodies (Louis 2004, 307). Unlike their European counterparts, however, U.S. cities generally had smaller populations and more available land nearby for dumping, making epidemics less frequent occurrences until population density and industrial output began to rise in tandem (Louis 2004). By 1840 the nation was less and less one of quaint villages and starting to resemble the urbanization that had already taken off in Europe, with 10.8% of the U.S. population living in cities (Louis 2004).

3.1.1: Chadwick and The Miasmatic Theory and Public Health

Melosi (2000) parallels the rise of planning in concert with the rise of germ theory around the turn of the twentieth century and its effect on sewage, water systems, and sanitation efforts in cities following the Industrial Revolution. Tracing germ theory's rise and growing influence on sanitary conditions in cities from Great Britain to the United States, Melosi reveals the confluence of medical and civic thought at the intersection of sanitation, the beginning of what can broadly be called a modern system of waste management.

The rapid concentration of population in denser and denser city centers during the Industrial Revolution created many potential pockets for disease to spread to the level of an epidemic, especially cholera and yellow fever. Additionally, industrial pollution in cities was increasing the prevalence of other non-disease health problems, such as respiratory issues. The earlier half of the century was dominated by a social or moralistic understanding of disease. Many saw disease as a sign of personal failing or flaw, intimately linked to poverty and race. A seminal study of the relationship "between pauperism and sanitary conditions" was carried out in London by Edwin Chadwick along with three other physicians and published as a *Report on the Sanitary Condition of the Labouring Population of Great Britain* in 1842. Chadwick's report, influential with both government officials and citizens sold more copies than any other government publication previously and represented the maturation of a movement away from a strictly moralistic and fatalistic understanding of poverty as the cause of ill health. Rather, the report argued that the opposite, in fact was true: ill health contributed to poverty and disease had environmental roots (Chadwick 1842). The report suggests a strong link between pollution and disease, and points to pollution prevention as the most effective path to combating disease.

However, without a full understanding of the microscopic organisms that we today know cause disease, Chadwick and others were left to postulate to the existence of miasmas within pollution as the cause of disease (Melosi 2000). Miasmatic theory holds that disease grew out of "putrefying organic waste, bad smells (miasmas), and sewer gases," rather than understanding disease as contagious from person to person (Melosi 2000, 31). Chadwick's system of public works was highly focused on supplying homes with centralized clean water and sewage removal services. As Melosi points out, “garbage and other solid wastes were treated as nuisances rather than as health threats at this time,” and therefore solid waste management primarily consisted of street cleaning (Melosi 2000, 33). Although the cause of disease was misidentified by Chadwick and other Miasmatics, the public infrastructure-based solutions proposed did help to effectively combat disease in London and the rest of the industrializing world took notice.

3.1.2: Griscom and Engels on Working Class Conditions

The first comprehensive study of health issues in the United States was conducted in New York City under the direction of inspector John H. Griscom, and the findings were published in his 1845 report *The Sanitary Condition of the Laboring Population of New York*, a reference to Chadwick’s work from several years earlier (Griscom 1845). The report so negatively characterized the environmental state of New York’s tenements that the Board of Aldermen refused to reappoint Griscom and little directly came of his efforts (Melosi 2000, 43). Among the interventions that Griscom advocated for were “housing improvements, construction of drinking and waste water systems, and regular street cleaning and refuse removal” (Corburn 2009, 30). Following Chadwick, Griscom’s survey connected environmental factors to health outcomes for one of the first times in a U.S. city. Radically, rather than blaming the disenfranchised for their poor living conditions, Griscom argued that inequalities in living conditions led to unequal health outcomes. In framing the issue to businessmen and politicians, Griscom hoped to make the case for better housing in the name of self-interest; for him, better living conditions meant fewer sick workers, and fewer sick workers would lead to less labor pool turnover and greater profits (Burrows and Wallace 1999).

Alternatively, Friedrich Engels also completed an in-depth look at the conditions of working class people in England that came to a different conclusion when placing blame for the abysmal tenement environment. Engels, in his report *The Conditions of the Working Class in England in 1844*, argues that harsh working conditions, little to no access to medical care, and inadequate housing all "combin[ed] to undermine the health of the workers" over time (Engels 1847, 118-119). Where Griscom refused to place blame on the poor for their living conditions, Engels more strongly accused polluting industries for creating unhealthy neighborhoods and workplaces (Corburn 2009). However, sanitarians in the United States chose to ignore Engel's call to dismantle or alter the capitalist system and Griscom's slightly weaker appeal to build more and better quality public housing, later opting instead for a utilitarian approach to the issue of working class conditions.

3.1.3: The Civil War, Reconstruction, and Florence Nightingale

The Civil War and following reconstruction efforts dominated political agendas for the next two decades of U.S. history and few new interventions or reports were carried out. One notable exception comes from a report published by the Citizen's Association two decades after Engels' and Griscom's reports. The Citizen's Association, a prominent civic reform organization in New York City, completed one of the first large-scale "sanitary survey[s]" in 1864 (Peterson 1979, 89-90). This survey "yielded numerous administrative and environmental proposals" and provided the basis for what could be considered comprehensive urban planning, although with a narrower focus on only health concerns (Peterson 1979, 89-90).

Even acknowledging the disruptive years of the Civil War, the growth of the sanitation field, and thus of the planning field, is not without ties to this period. Though the Civil War had disrupted the rising momentum of sanitation and public health, several important battlefield medical and sanitation improvements were made. These "help[ed] to make way for more formal governmental responses to the ideas generated at the sanitary conditions," which prior to 1861 had been working to turn Chadwick, Griscom, and Lemuel Shattuck's recommendations into national policy (Melosi 2000, 66).

In the early 1860s sanitary innovation was spurred forward by many women's' groups focused on soldier health, with these growing into larger sanitary commissions and citizens' groups after the war was over. Most well-known for her work in solider health during this period is Florence Nightingale, an Italian-born nurse who traveled to the Crimea in 1854 ("Florence Nightingale" 2006). Nightingale was a well-known proponent of the miasmatic theory of disease supported by Chadwick and others (W. Moore 2007). Upon arriving in Crimea, she set to work with the other nurses and soldiers well enough to help her scrubbing the makeshift hospital ("Florence Nightingale" 2006). She argued that "overcrowding, filth, and poor ventilation all contributed to the illness she saw before her," going on to become an expert in military medical practice and is seen today as the progenitor of modern nursing ("Florence Nightingale" 2006). Despite all of this, Nightingale in fact ridiculed germ theory during the remainder of her life, even after the discoveries of Louis Pasteur and Robert Koch became widely accepted in the 1880s (Nikolova 2012).

Additionally, several factors directly attributable to the Civil War aided the continued expansion of sanitation reform. First, this period of war saw continued urban disease epidemics, especially as more and more people began moving into cities after the end of the war. Soldiers, formerly enslaved people, and European immigrants flooded into cities and these population density increases strained already overcrowded neighborhoods and were a factor in disease outbreaks of the time (Corburn 2009). Sanitarians were desperately needed to address the issue of disease and this need only increased after the Civil War.[5]

Second, a surplus of engineers trained in large infrastructure projects like railroads and canals were in need of work following their discharge from wartime service (Melosi 2000, 69). While university education in the U.S. on the whole stressed humanities and pure sciences, programs such as those at Rensselaer Polytechnic Institute and other technical colleges began offering courses in civil engineering in the late 1820s and early 1830s (Melosi 2000, 70). However, military needs during the Civil War dictated the training of more engineers, many of them trained at West Point (Melosi 2000, 70).[6] This "new breed" of civil engineers was increasingly available to cities after the end of the war for urban infrastructure projects devised of by sanitarians.

Third, abolitionist groups had achieved their goals and now had the ability to focus their energies on a new cause. Primarily composed of women, groups of

---

[5] Crucially, however, moralistic attitudes that held the disenfranchised responsible for their own poor living conditions still abounded in the decades immediately following the Civil War. These beliefs were rooted in overt racism towards European immigrants and especially towards formerly enslaved African-Americans, and sanitarians often perpetuated these beliefs in appealing to wealthy elites for funding to support public health interventions (Corburn 2009).

[6] It is estimated that as many as fifteen percent of pre-Civil War U.S. engineers were trained in the program at West Point (Reynolds 1991).

this type had also often been involved with efforts to aid the sick and wounded on the battlefield. The Women's Central Association of Relief for the Sick and Wounded of the Army spawned the United States Sanitary Commission, which pushed for public health interventions like those of Nightingale to improve soldier conditions (Melosi 2000, 66-67). "Thousands of working-class and middle-class women" had been occupied by first abolition and, during the war, solider health needs (Melosi 2000, 67). After the war, many of these women took up urban sanitation as their new cause after being exposed to it as military nurses. Each of these three factors contributed to the United States' accelerated capacity to build large public infrastructure projects addressing public health issues after the Civil War.

3.1.4: Early Triumphs in Sanitation: Fighting Disease

In the 1870s, the city of Memphis was hit by a series of yellow fever outbreaks that took a devastating toll on the city; in the summer of 1873 an estimated one-sixth of the city's population was killed. Yellow fever struck again in 1878-79 and the growing crises were making national news (Melosi 2001, 170-171). Part of the solution, was the implementation of a separate sewer conveyance system, rather than a combined flow system. The separate conveyance system, also known as the Memphis system, discharges household waste water regularly but storm water was handled separately by surface streets (Zimring 2012). George

E. Waring, Jr. introduced this type of sewage system as being more sanitary than the traditional combined system, and while his claims of greater sanitation proved unsubstantiated the Memphis system was estimated to cost one-tenth of a combined system and require substantially less water volume to operate and was adopted (Waring 1894; Melosi 2000, 154-160).

However, more than the debate that raged between engineers over the merits of separate and combined sewage systems, the problems in Memphis launched such a large-scale planning process as to become the basis for the entire profession in the decades to come. The National Board of Health, created by Congress in response to the crisis in Memphis, was asked by Tennessee to provide them with more than just quarantine procedures (Peterson 1979, 90). The State Board of Health of Tennessee wrote to the National Board of Health:

> "Whereas proper sanitation...can only be accomplished through the means of a *thoroughly systematized and comprehensive plan*, and the city of Memphis is now in such a condition as to demand the early adoption of a *plan for future operations* relating to its permanent sanitation...Be it resolved, that the co-operation of the National Board of Health be requested for the purpose of making a *thorough and complete sanitary survey* of the city...with a view of indicating *what conditions exist*...and *what measures should be adopted*...with the *methods* of their accomplishment *and the estimated cost* of the same" (National Board of Health 1879, 416; emphasis my own).

Planning as a field rests on nothing if not comprehensive plans that indicate current conditions and what methods and tools could be used to achieve a better future outcome. The nine proposals that formed the bulk of the Memphis report and plan can hardly be called a comprehensive plan by today's standards. They do show, however, that sanitary engineers were conducting large-scale surveys and planning in cities with a view towards change (Peterson 1979, 90-91). More a method of planning-for-health applied to cities than planning-for-cities encompassing health, the Memphis crisis and resulting proposals nonetheless highlight the role of planning in early sanitation efforts and its complementary relationship to engineering and technology. As I will go on to show, unfortunately, planning in this sense did not continue as a vital part of solid waste management.

By the 1880s, fledging citywide water-supply systems were growing in terms of both absolute numbers and complexity; Philadelphia's model system even including several basic water quality safeguards (Albert 1988). Street pavement also improved in design nationwide around the turn of the twentieth century as the need for it to withstand heavier traffic from automobiles after their introduction in the 1890; additionally, sturdier pavement made for easier cleaning of horse manure, one of the major contributors to street (un)cleanliness along major thoroughfares (Melosi 1981, 32).

3.1.5: Solid Waste Collection and Disposal: A Public or Private Responsibility?

As for solid waste collection and disposal, the problem proved much more difficult to modernize than street cleaning or sewage removal in many cities. Water and waste water systems began evolving and expanding into truly public infrastructure around the turn of the century, but garbage was often an afterthought, and more difficult to manage than other environmental sanitation concerns which could be quite literally flushed away (Melosi 2000, 175).

The question of responsibility for household and business waste was still unsettled, and can be seen readily in debates over the provision of another public service: delivery of fresh water. Often still operating under the inaccurate miasmatic theory of disease, sanitarians nonetheless recognized the need for pure water free of human and animal waste and the demand for waster infrastructure grew rapidly, with forty-five waterworks in 1830 to almost 10,000 by 1924 (Melosi 2010, 217). During the same time, however, rising costs of filtration technology to achieve new purity standards, and increased capital outlays required to reach expanding customer markets made cities question whether private companies could be relied on to provide quality water service (Melosi 2010, 217). Large cities began to pressure private companies to sell off assets as rates increased and governmental oversight became more accepted by the end of the nineteenth century (Melosi 2010, 218).

While it may seem that public ownership of the water supply connotes an *a priori* "right" to water, in reality the primary reason for public ownership is tied to the financial tools available to municipalities that corporations cannot take advantage of as easily. Municipalities, with their ability to incur large amounts of debt through bonding for capital projects, were more able to expand the water supply infrastructure as technological complexity grew (Melosi 2010, 218). Therefore, a persuasive efficiency argument was made by sanitarians, and later planners, for the public ownership of these systems, which would set the stage for other services that are now publically provided. The case for solid waste management services, however, did not follow directly in the vein of water supply, in part due to the unique characteristics of the sociotechnological system itself.

Regarding solid waste, private companies and individuals often could not sufficiently coordinate regular collection in all neighborhoods. The piecemeal approach of overlapping private waste collection companies was seen as ineffective at keeping cities clean, so the issue fell to municipalities in the 1880s and 1890s, who were faced with two choices in the collection of refuse. Municipalities could either contract hauling operations to private companies through a bidding process, or they could mirror water supply by creating their own municipal hauling force (Melosi 1981, 28). The majority of cities chose to contracted services out to private refuse collectors rather than employing their own collection forces (Melosi 1981, 28). This was popular because contracting MSW services required little to no capital outlay on the part of the city but afforded some small level of oversight that had been unavailable in a fully privatized scheme

(Melosi 1981, 28). In effect, cities took the opposite tactic in ensuring sanitary handling of refuse as they were taking with the sanitary delivery of water. Private haulers did not need to fund expensive capital infrastructure projects as was required in water delivery, and cities could benefit from competitive pricing between companies and the ease of having one fewer thing to operate on a day to day basis.

The contract system was not without flaws. A common complaint with municipal waste hauling was that it bred political corruption, with sanitation officials employing workmen as political favors (Melosi 1981, 29). Contract awarding, on the other hand could also be politically corrupt. In Chicago, the Civic Federation “charged that the contractors collecting the garbage were swindling the city and completing only half the work promised” (Melosi 1981, 29-30). This concern for corruption was often not enough to surmount the efficiency arguments being made by a burgeoning class of municipal bureaucrats attempting to streamline city operations, however. Especially in smaller cities with fewer financial resources, the benefits of private waste hauling contracts far outweighed the ethical argument that sanitation services were the responsibility of cities due of their need to protect the public health and safety (Melosi 1981, 30-31).

While system boundaries were being stressed and extended in the realm of some services, such as water supply and street cleaning, the boundaries were also contracting inwards to limit the public oversight of solid waste. Past decisions in public service provision can be tough to overcome. Even today, many cities choose to contract with private hauling companies for residential waste yet maintain their own street cleaning fleet. The abdication of MSW hauling to private contractors in the late nineteenth century set the pattern for the twentieth and twenty-first centuries, and planning as field has not largely revisited this question since.

3.2: The City Proud: Civic Reformers, the City Beautiful, and Sanitary Reform

3.2.1: Colonel George Waring and His White Wings

One of the most important models for municipal refuse collection in the United States at the end of the nineteenth century was in New York City under the direction of George Waring. While new ranks of civil and sanitary engineers grappled with technological and procedural advances, Waring, along with civic reformers and especially women's progressive groups provided a key ingredient to permanently altering the course of solid waste management in the United States: community pride and awareness.

Colonel George E. Waring, Jr. came to prominence as an engineer with his "Waring" system for separated sewage conveyance, also referred to as the "Memphis" system for its first major application in the country (Melosi 1981, 56).

Waring, a longtime friend of Frederick Law Olmsted and a collaborator on his famous design for Central Park, was appointed by mayor William L. Strong in 1894 as the Street-Cleaning Commissioner of New York City, after Strong's successful defeat of Tammany Hall (Melosi 1981, 54-59).[7] Waring, an adherent of the Miasmatic Theory of public health, proved to be quite successful in his role, being focused on action, especially at the community and neighborhood level, to address public health through environmental cleanliness (Melosi 1981, 59-60). In an iconic move, Waring determined that a key to increasing public awareness of the link between health and garbage was that citizens should associate refuse collectors with members of the health professions. To do so, he changed refuse collector uniforms from brown overalls to stark white jumpsuits, and the famous White Wings were born (Melosi 1981, 65-66).

More than simply changing the uniforms (see Figure 1), Waring understood the need to overhaul the public's perception of refuse workers. White Wings marched throughout the city on parade several times a year during Waring's tenure in the Street-Cleaning Department (Melosi 1981, 65-66). Labor reforms brought

---

[7] Interestingly, the position of Street-Cleaning Commissioner was first offered by Strong to Theodore Roosevelt, who turned it down in favor of an appointment as NYC Police Commissioner, a choice which helped lead to his eventual election to governor of New York. See Theodore Roosevelt, *Theodore Roosevelt: An Autobiography*.

additional allure to employment under Waring, including improved worker grievance processes, $60 per month salaries, and eight-hour work day limits (Melosi 1981, 65-66). Vowing to take the Tammany Hall nepotism and corruption politics out of his department, his workforce was able to clean up quite literally both the streets of New York and the stereotypes of corrupt and lazy public workers (Melosi 1981, 65-66). As Waring told the *New York Times* in 1896, it was his "intention to force the department on to the attention of the people in every possible way" so that eventually "political influence would have no weight against [it]. (Waring, *New York Times* October 11, 1896 2).

A commitment to civic pride and duty also helped foster the individual-level participation Waring required for possibly his biggest innovation, though not his biggest success story: source separation. Waring instituted city-wide "primary separation" of wastes into three categories at the responsibility of the individual homes and businesses. Garbage (organic waste), rubbish (inorganic waste), and ashes were each to be kept in separate containers until they were collected (Melosi 1981, 69). Although initially unpopular, the combination of the innovation of source separation with public outreach programs like the Juvenile Street Cleaning Leagues he started (Melosi 1981, 74-76), and the Ladies Health Protective Association (Melosi 1981, 73) meant that source separation proved fairly successful in New York under Waring. The coalition he courted of grassroots organizations helped to spread the word about source separation and educate the masses on how to do it properly. All of this meant Waring was able to bring greater visibility and respect to street cleaning, sewage systems, and refuse collection and disposal.

Figure 1: White Wings Escorted by Police during a 1911 Garbage Strike (source: Department of Sanitation New York)

3.2.2: Women's Civic Groups: Promoting Sanitary Reform at the Meso-Level

Progressive civic reform groups, a staple of the decades before and after the turn of the twentieth century, were also critical to the early attempts to solve sanitary and solid waste crises in industrialized cities. Amidst the many general and specific causes that a citizen could rally behind, urban environmental causes were especially attractive to champion due to the large cross-section of the urban population affected by issues like smoke abatement and noise pollution (Melosi 1981, 109). Progressive causes were often moralistic, reminiscent of the early view of links between sickness and poverty, but decidedly adherent to the belief that humans could be good citizens once their environments were clean and healthy (Melosi, 1981 105-110; Addams 1910).

Civic reformers valued such modern ideals as conservation, corporate-like government, efficiency, and social engineering. However, the moralistic overtones were especially targeted at "cleaning up" cities in more than just a physical sense. As much as reformers hoped to remove causes of disease, eugenic conceptions of race as a "valid biologic category" contributed to their goals of removing or changing the behaviors of pathogenic people (e.g., African Americans, Jews, and Eastern and Southern European immigrants) (Corburn 2009, 31). Settlement house workers were at the forefront of these attempts at cultural indoctrination, pushing to Americanize those that were culturally dissimilar from white middle-class aesthetic and racial ideals (Corburn 2009; Addams 1910). As Carson (1990) argues, settlement workers and civic reformers believed that "local residents should be educated to understand the connections between poor sanitary conditions, recurring illnesses, and *high morality*" (72; emphasis my own).

Women were often at the forefront of progressive groups taking aim at pollution and health. Many saw sanitary reform as a natural extension of the home sphere and women were authoritative advocates for issues that they were considered the experts on (Melosi 1981, 117). In a project deemed "municipal housekeeping," these women's groups engaged in activities ranging from painting playful slogans on trash bins to becoming civic watchdogs when Tammany Hall officials defeated Mayor Strong and no longer put forth the same effort as under the leadership of George E. Waring, Jr. (Melosi 1981, 117-124).

In fact, Jane Addams, famous in the field of planning for her contributions to a social, grassroots approach as the founder of Hull-House, was also a sanitary reformer. Garbage collection and sanitation were central concerns and the workers of Hull House made them a focus of their activity and action (Addams 1910). As Jane Addams writes,

> "The system of garbage collecting was inadequate throughout the ciy but it became the greatest menace in a ward such as ours, where the normal amount of waste was much increased by the decayed fruit and vegetables discarded by the Italian and Greek fruit peddlers, and by the residuum left over from the piles of filthy rags which were fished out of the city dumps and brought to the homes of the rag pickers for further sorting and washing" (Addams 1910, 281).

Because "the death rate remained high and the condition seemed little improved" in her ward, she attempted to secure the contract for garbage collection for Hull House's neighborhood and was eventually appointed "garbage inspector of the ward" (Addams 1910, 285). Addams lectured on "municipal housekeeping," or the idea that the street and neighborhood were a natural extension of the "womanly task" of maintaining one's home, and pressured Chicago City Hall to increase reliability of garbage collection (Addams 1910, 287). However, as Addams' popularity grew in relation to her position as garbage inspector, the "all-powerful alderman" saw fit to reorganize positions within the sanitation department in such a way that "only men were eligible" (Addams 1910, 289). Even so, the surveys conducted by residents "to document unsanitary conditions" did result in the physical improvement of living and working conditions for many communities in which settlement houses operated (Corburn 2009, 35).

The "meso" scale that such groups constituted provided citizen observation and collective action that was missing from many public agencies at this time. And although many outcomes of Progressive Era reformers can be viewed as wins in sanitation and solid waste planning, they should also be understood as "meliorative, not radical or revolutionary *(sic)*" (Wilson 1989, 78).

3.2.3: Sanitation and The City Beautiful Movement

Although typically associated with aesthetics and grand architecture that attempts to replicate Classical and Renaissance buildings in the middle of industrialized downtowns, the City Beautiful movement was equally concerned with sanitation, cleanliness, and how such environments could transform (primarily the urban poor and immigrants) into their own conception of good, clean, American citizens (Wilson 1989). Jon A. Peterson (1976) argues that the three pillars of City Beautiful movement were municipal art, outdoor art, and civic improvement (416). The huge number and variety of small and medium-scale civic reform groups, "particularly village improvement societies," across the United States in the last decade and a half of the nineteenth century were more likely to recommend small-scale and piecemeal changes and general cleanliness to large scale urban planning efforts (Peterson 1976, 429).

Further, while perhaps one of the best exempla of City Beautiful ideology in action, Burnham's Chicago World's Fair, with its grand, axiomatically planned boulevards and magnificently large temples to technology, is less emblematic of the movement prior to 1901 (Peterson 1976, 429). Rather, it has in some scholarship been forgotten that "the fair was a sanitary wonder" (Wilson 1989, 57). "The paving, nightly sweeping and cleaning, many water closets, filtered drinking water, and sewage treatment at the exposition were the apotheosis of nineteenth-century urban sanitary engineering," and the World's Fair would be the pinnacle of sanitation planners for decades to come (Wilson 1989, 57).

Wilson (1989) characterizes the City Beautiful movement as having been mislabeled by history's "winners," the City Practical, as "aesthetics-obsessed, socially primitive, and in-utilitarian" (3). In fact, "citizen activism and the recapture of a sense of community [were] at its core" (Wilson 1989, 37). Indeed, municipal and outdoor art without sanitary reform and management was compared by one member of the Women's Municipal League in New York City to a "diamond ring on dirty hands" (Bartlett Crane 1906, 1). The City Beautiful adherents believed in multiple solutions to address the interrelated problems of urban conditions (Wilson, 1989). Indeed, as Charles Mulford Robinson, author of *The Improvement of Towns and Cities; or, the Practical Basis of Civic Aesthetics*, said

> "There is no one panacea for the ugliness, dreariness, or monotony of towns and cities; there is no one road to victory" (quoted in Wilson 1989, 47).

The social and pragmatic aspects of the City Beautiful have been left out of planning history by many of its historiographers, and it may have better been labeled the City Social after all (Sandercock 1998).

3.2.4: The Professionalization of Planning: Cementing of a Rationalist Frame

Civic reformers valued such modern ideals as "conservation, corporate-like government, efficiency, and social engineering" and sanitary engineers were in many ways the best equipped to fulfill these needs (Schultz and McShane 1978, 389). Their valuable skillset led engineers into the role as one of the "strategic elite" that Suzanne Keller (1963) characterizes: "a minority of individuals designated to serve a collectivity in a socially valued way" who "have a general and sustained social impact" on a large number of members of society" (4, 20). Professionalization which kept the ranks closed to many helped foster some of the exclusivity attributed to sanitary engineers (Schultz and McShane 1978, 401).

However, in many ways sanitary engineers were the first urbanists, aware of all the infrastructural networks and systems in a way that no other profession was. This knowledge benefitted them more than just in its ability to secure their role within expanding governmental administration systems at the municipal level; engineers became overwhelming the first generation of city managers (Schultz and McShane 1978, 409-411). And as Wilson (1989) states,

> "Though they made some contributions to comprehensive planning, engineers more often won civic admiration for solving specific, immediate problems of drainage, water supply, and traffic" (37).

The mantra of efficiency in terms of cost-reduction, a guiding principle of sanitary engineers, worked its way into the upper levels of local government through their status as strategic elites (Wilson 1989). The effects of a technocratic attitude towards urban planning and public administration are still felt today thanks to the legacy of sanitary engineers and the "defeat" of the City Beautiful perspective.

3.3: Building Up Slowly: Collection and Disposal in the Early Twentieth Century

Reformers and engineers of the late nineteenth century proved to have been overly optimistic that they would soon “solve” the waste problem. While some great strides were made within sanitary reform in a few short decades, predominantly in street cleaning efforts, effective approaches to collection and disposal of household refuse were not as easily modernized through technological innovations alone.[8] Maturation happened much more quickly for water supply and wastewater removal, the cousins of garbage collection and disposal, but by the 1920s, primarily through the invention of sanitary landfilling practices, garbage could be fully considered a public infrastructure project that cities no longer shied away from (Melosi 2000, 204). A growing trend towards municipal oversight of garbage collection and disposal (away from private companies and contracts) brought the responsibility fully into the public realm in most cities by the first decade of the twentieth century, but the debates still raged on about which methods were most effective for what types of cities (Melosi 1981, 156).

[8] Modernization here refers to a theoretical frame that sees social change as moving “in the direction of general improvement over the past” and (Dickson 2005, 1485).

The choice of collection methods, primarily split between Waring's primary separation scheme and combined-refuse schemes, often came down to balancing the potential ease/difficulty of sorting and collection, cost to the city, and what eventual disposal method would be utilized. The major driving factors in the battle over responsibility, however, came down to technocratic authority, power, and cash flow. Combined collection was considered easier for citizens, and cheaper to collect, though potentially less sanitary; separated collection increased the difficulty and cost of collection to householder and city but with the added benefit of being considered more sanitary and of better quality for cities employing reduction processes to dispose of waste (Melosi 1981, 157). "Wet" trash like organic waste and animal products needs to be picked up more frequently than ashes or inorganic matter. These different schedules, combined with the already semi-sprawling characteristics of many U.S. cities could also result in combined or modified solid waste management and infrequent service in neighborhoods that were less dense or farther from the urban core (Melosi 1981, 157). Differences in waste generation characteristics could also lead to inconsistencies in collection—"immigrants" in tight ethnically-similar communities often produced significantly less waste than their "American" counterparts, most likely traceable to cultural practices (Melosi 1981, 161).

3.3.1: SANITATION AND THE SEARCH FOR THE "BEST" SOLUTION

During this time period, adherence to the Miasmatic Theory of disease began declining as more information on bacteria became known, and this shift in public health discourse rippled into the fledging waste management sector. Whereas the emphasis in the age of miasmas was on "preventing illness by removing waste or providing water that appeared pure to the senses," Bacteriology was concerned with removing specific pollutants from the system (Melosi 2000, 103-104). Public health as a field, originally the purview of "sanitary engineers," became more and more separated into two groups: scientists and lab technicians who assumed responsibility for health by studying newly recognized microorganisms, and civil engineers who continued finding more and more efficient ways to remove water, sewage, and waste from urban areas (Melosi 2000, 104).

Although this bacteriological, or germ, theory would become the basis for our ability to fight and eradicate most diseases that plagued people at the turn of the twentieth century, it also shifted the focus of public health away from the environment and physical urban planning interventions and onto the individual and the biomedical interventions (Melosi 2000, 111). Filth became thought of by many, at least by laymen, as a nuisance issue rather than one of life and death, and the technological fixes of engineers seemed to many municipal bureaucrats enough to deal with this less consequential framing. Garbage, although it had its own share of innovations, was to take a backseat to other sanitary services (Melosi 2000, 261).

After Waring's introduction of source/primary separation, cities had multiple options to deal with their refuse problems. Citizens could be required to sort their own refuse before setting it out at the curb, or leave it combined. Garbage could be dumped at sea, in a landfill or on vacant lots. Cities could attempt to recapture some value through incinerating trash, or using "reduction" processes to squeeze byproduct liquid and oils from "wet" waste which could be sold while at the same time reducing the volume eventually sent to be dumped (Melosi 1981). Especially during World War I, there were even a number of successful swine-feeding applications for refuse, with cities as diverse as Worcester, MA; St. Paul, MN; Omaha, NE; Denver, CO; and Los Angeles, CA all incorporating the practice as major components of their solid waste management (Melosi 1981, 170).

3.3.2: A Lesson in Context-Specificity: Reduction and Incineration Plants

Disposal methods faced their own sets of challenges. Although incineration and reduction processes had both been somewhat refined by the beginning of the twentieth century, neither practice was able to surmount dumping due to its low cost and convenience. Incineration, quickly catching on as the primary method of disposal in Europe, did not have the same widespread success in the United States—U.S. incinerators had been hastily adapted from their European counterparts and were not well suited to the conditions of many U.S. cities' waste streams (Melosi 1981, 171-177). The biggest differences, the abundance of open and inexpensive land as well as energy resources such as coal and wood, mean incineration was not nearly as financially attractive an option in the U.S. (Melosi 1981, 171-172). The barrier of capital outlay was steep for many cities, with the return on investment margins too slim and the ensuing health problems too great to bring incinerators to many locales. Further, incineration when it was employed was often used for burning organic wastes, having been either separated at the source by citizens or simply a higher percentage of the waste stream than in European cities at the time (Melosi 1981, 172). Working to burn waste that was heavier and wetter, incinerators often used more fuel to burn the same volumes of garbage. Increasing fuel usage increased the overall costs and decreased the efficiency associated with incineration.

Incineration, therefore, a lesson to solid waste planners in the need for context-specific solutions. The technology developed for waste streams in Europe did not work the same when introduced to the dissimilar waste streams of U.S. cities. This key difference in performance of the same technology is emblematic of how engineers have approached solid waste management in the United States and will prove to be a pattern with other types of "universal" solid waste technologies (see sub-section 3.10.3).

Reduction plants also faced their share of problems. It is estimated that because they were only able to process garbage (organic waste), reduction plants could only handle 10 to 30 percent of the waste stream for a typical city (Melosi 1981, 177). Reduction plants were more popular in the United States than across the Atlantic. It was thought that U.S. waste was a better fit for the process, namely because Americans tended to throw away garbage from which more residuals could be recovered (Melosi 1981, 177). Excluding many ethnic enclaves of recent immigrants, the U.S. urban waste stream included more "valuable food matter" and especially meat refuse that in turn created higher yields for reduction plants (Melosi 1981, 177). The composition of U.S. waste streams as compared to its European counterparts is a sociotechnological pattern; in this case, a cultural practice (of disposing of greater volumes of food scraps) increases the viability and profitability of a technology (reduction plants), and the technology in turn dictates the continuance of a cultural practice in order to maintain the system. Such sociotechnological patterns that go unobserved or unexamined by technology designers still assert effects whether we notice them or not, while planning with them in mind can lead to synergies and interventions not previously considered to be within the boundaries of the system.

Frustratingly for many cities, the cost of constructing a reduction plant was quite high and a large, dense population was necessary for it to run effectively;

however, cities that met these requirements were too often already so dense that finding property to site them was next to impossible (Melosi 1981, 180). The stench often brought residents out in protest, as in the case of a reduction plant on Staten Island in 1916, but often the economic interests of the wider city won out against the environmental and nuisance interests of nearby residents (Melosi 1981, 181).

3.3.3: Sanitary Landfills: Cheap, and Better Than Nothing

Dumping refuse was by far the most common method of disposal, in either waterbodies or on land and in unsanitary landfills. Although a nearly universally condemned practice, dumping waste into water continued to be a large part of many cities' waste management schemes until sanitary landfills began to catch on after the first quarter of the century (Melosi 1981, 163-168). Eventually, sociotechnological conflict in the wider system erupted in legal battles that raged between municipalities and beaches littered with waste washed back to shore; this became enough to curtail the practice through stricter regulation and guidelines, but of course it still carries on unsanctioned even today (EPA Region 5 1998). Dumping waste on land, or sometimes using waste intentionally as fill for coastlines and ravines, was more popular and inexpensive than many other disposal methods of the day.

Some cities, waiting to be able to afford the capital costs associated with newer waste disposal technologies like incineration and reduction plants, dumped waste simply until they could afford a better alternative (Melosi 1981, 168). Also known as “controlled tipping,” “trench,” “cut and cover,” and “fill and cover,” sanitary landfills gained widespread purchase beginning in the 1920s (Melosi 1981, 168). Typical sanitary landfills would sandwich a layer of organic waste between a layer of ash, inorganic waste, and/or street sweepings that was approximately twice as deep, sometimes with chemicals sprayed to slow decomposition of the organic waste (Melosi 1981, 168). More expensive and laborious than unsanitary land dumping, these landfills would eventually become the norm in the United States thanks to abundant land far enough away to be of nuisance and cheap fuel for transportation. Jean Vincenz, the commissioner of public works for Fresno, CA popularized early methods of U.S. sanitary landfilling and by the 1950s it was the first universally accepted disposable method for cities across the U.S. (Melosi 2000, 271-272). A new revolution in disposal would not come until the challenges of the environmental movement in the 1960s and 70s, as will be shown in the following sections.

3.4: A Brief Interlude: Waste as Resource During the World Wars

Critically for the purposes of this study, a different frame towards waste began to emerge in some circles during this period. A view of waste as a resource to be utilized rather than forgotten was spurred on by practices such as reduction and continuing on from earlier rag pickers and scrap metal dealers (Rogers 2006). "Recycling" in this sense was motivated primarily by economic rather than social or environmental means, and includes everything from turning old rags into paper products to precursors to today's biomass waste-to-energy technologies (Melosi 1981, 181-186).

Although economic drivers and resource squeezes caused by international wars were the primary reason for recycling prior until the 1950s, it still rarely paid for itself. As sanitarian Charles V. Chapin wrote, he knew of no recovery method "where the value of the products sold yielded a new profit over and above the cost of collection and disposal" other than feeding waste to pigs (Chapin 1911, 288).[9] Many municipalities were able to recoup some of their collection and disposal costs with revenues generated from these early recycling efforts, but the technologies did not pay for themselves. For co-generation projects, like steam-producing incinerators, the inability to use the steam generated at night from the process was a major barrier on top of capital costs above the already costly general incinerators (Melosi 1981, 186).

---

[9] Scientific studies in the 1930s would show that feeding garbage to swine led to increases in infection by the *Trichinella spiralis* parasite and this knowledge combined with the difficulty of keeping large enough pig farms to dispose of the growing volume of urban waste led to the demise of this "primitive" disposal method (Melosi 2000, 273).

Concerns touching on more than just financial obligations lead to elevated interest in recycling during World War I, as the introduction of stimuli external to the system (i.e. international wars) led to rationing and reuse in the U.S. The need for salvaging more materials forced ordinary citizens and public officials to pay attention to their wastefulness, at least for a while. With the advent of the sanitary landfill, nearly all experimentation paused. Who had incentive to search for a way to recoup higher costs when a socially acceptable alternative existed that combined higher health and lower costs?

The largest hurdles to wider adoption of recovery and utilization processes were the other disposal processes they were up against. The plethora of disposal options and the cheap costs of land and fuel meant that rather than considering the problem of waste management from a purely environmental or social viewpoint, everything came down to a cost-benefit analysis (Melosi 1981, 187). Although any large-scale adoption of these sorts of practices did not occur, the experimentation meant that at least in some small pockets the false frame waste going forever "away" was beginning to crack. However, it would take several decades and another push from community planners moving engineers aside to address the problem from a more nuanced frame. While engineers had sped up technology to meet the needs of industrialized cities, the "perfect" solution remained more than a little out of reach, and a second wave of public interest after a few decades of complacent consumerism was to be the next chapter in U.S. solid waste management.

3.5: Business as Extra-Ordinary: Explosion and Expansion After the World Wars

While critically important decades to U.S. history, the period between the two world wars saw little in the way of new methods for waste disposal. The numerous recycling and reduction efforts undertaken by governments, companies, and private citizens during wartime austerity were relinquished with the peace that followed. However, wartime efforts did lead to two major revolutions in the material flows of our society that we are still grappling with in solid waste management today: plastics and sprawl.

3.5.1: Changing Waste Stream Composition

The "jarring return to a peacetime economy" after World War I spun the United States into a brief but astronomical period of prosperity in the 1920s, fed by investment capital and technological advances (Melosi 2000, 262). Although the following equally astronomical economic collapse of the Great Depression led to austerity, the American instinct to consume was only at best paused by the years of extreme unemployment (Cross 2000, 67). The return to an economy not devoted to the war effort led to a massive influx of consumer goods and a doubling down on a commitment to defining themselves through these goods. As Cross (2000) notes in *An All-Consuming Century*:

> “After the war, American’s did not simply pick up where they left off before the Depression. They fulfilled the dreams that the years of hardship had nourished” (67).

All these consumer goods were especially notable in their effect on the U.S. waste stream composition. The chemical industry had exploded with the wartime economy, and without that outlet many companies began re-tooling their products and processes for domestic sales. Fabrics, kitchen goods, flooring, cosmetics, rayon, cellophane, antifreeze, any number of paints and dyes, all products of a wartime economy and companies jumped to market them to U.S. consumers (Melosi 2000, 263). A new type of domestic consumption was born, and, coupled with an overhaul in emotional marketing, that in turn translated “human relations into commodity relations,” the U.S. waste stream would never be the same.. (McChesney 2008, 265). Plastics were a new source of input to the system of municipal solid waste management in the United States, which had developed to primarily serve organics, metals, and ashes. New inputs to sociotechnological systems typically result in one of two adaptions: rejection of the input as outside the system boundaries, or incorporation of the input that causes the boundaries of the system to expand.

Horse manure and ashes were replaced by new types of “modern” waste

(Melosi 1981, 193). Glass, metals, and plastics all showed an increase in percentage in the waste stream (Melosi 1981, 193). Wood products were now manufactured out of plastic, and cotton fabrics were replaced by synthetic counterparts (Cross 2000, 91). The consumerism brought with it a need to advertise all these new products in a novel way, and packaging quite literally exploded the amount of paper being thrown away. Paper quickly became a primary characteristic of U.S. urban waste, and by 1977 paper products accounted for over 31% of the waste generated in the U.S. (Melosi 1981, 194). The consequences of paper's explosion as a waste stream component had major consequences for U.S. forestry production (Skog, et al. 2000). For example, whereas "rag stock a large share of fiber input in the early part of the century," wood pulp and fiber came to be used more as more paper was needed; this corresponds to a higher demand on the forestry industry and thus has a negative impact on the global climate (Skog, et al. 2000, 81).

Even more disturbing than the switch in material composition of products was the alarming rate at which items were becoming "temporary." Although polyethylene terephthalate (PET) plastic soda bottles would not be introduced until 1978, even the glass containers that individual beverages were packaged in would contribute to the throwaway culture developing at the time (Magoc 2011). The forces of fashion have always caused humans to covet the possessions of others, but rising commercialization during the Industrial Revolution had accelerated the speed at which items gained and lost their favor. As Neil McKendrick (1982) writes in his introduction to *The Birth of a Consumer Society*,

> "where once material possessions were prized for their durability, they were now increasingly prized for their fashionability. Where once a fashion might last a lifetime, now it might barely last a year" (1).

New technology and a general rising of disposable income was speeding up the turnover rate of goods (Cross 2000, 91). And every planner's enemy, sprawl, was compounding the problem.

3.5.2: Suburbanization and the Weight of Collection

Suburban auto-dependent culture exploded after World War II in tandem with waste generation and material composition shifts. The largest single portion of a city's sanitary budget tended to go to the collection of waste from those who generated it, i.e. curbside collection (Melosi 2000, 264-266). This step in the process, no matter the eventual disposal method employed by a city, requires immense human labor resources, with transportation costs increasing the farther away a landfill is from the denser urban center (Melosi 2000, 264-266). This is just one example of how cities are complex systems always in a state of fluctuation for which there can never be a permanent "solution" (Lanham, et al. 2016).

Sprawl, with its constant expansion of city limits either literally through annexation or effectively through the rise of bedroom communities, drove the costs of collection up even more, and the costs associated with it did not go unnoticed (Melosi 2000, 263). Technological advances in the use of motor vehicles, transfer stations, and types of secondary transportation such as barges and railroad cars were all adopted to help offset the rising costs of collection (Melosi 2000, 267-268). The literal weight of suburbanization hampered central city's abilities to maintain service levels for refuse collection as well as other sanitary services like water and wastewater (Melosi 2000, 283-286). The solidification of the core-periphery paradigm during this era of rapid sprawl is still felt today in solid waste management (see 3.7.3 for a more detailed description of the core-periphery model of unequal development).

3.6: Solid Waste as "Third Pollution" and its Role in the Environmental Movement

As with the revolution in public health at the end of the nineteenth century, the 1960s in the U.S. saw a similar revolution in the relationship between the environment and health. Unending consumerism and suburbanization were coming under question as people became unsatisfied with the bargains being struck to balance development and preservation (Gottlieb 1993, 36). The 1960s and 70s saw a renewal in environmental activism, and waste management was once again thrust into the spotlight of public attention. This attention was not only from engineers as in previous decades, but swelled into a popular movement thanks in part to Rachel Carson's *Silent Spring* (1962), concerned about the use of chemical pesticides, and Paul Ehrlich's *The Population Bomb* (1968), arguing that all environmental problems stemmed from over-population (Cross 2000, 150). More than protests or academic interest, this period of revolution in solid waste management was marked by the introduction of landmark legislation at both the national and state levels (Melosi 2000, 292). Coupled with a renewed interest in garbage "crises" fueled by media coverage of the infamous sea voyage of the *Mobro 4000*, serious recycling and even nascent beginnings of a zero-waste movement began to take hold (Magoc 2011).[10]

3.6.1: Waste as More Than Nuisance

William Small, author of *Third Pollution: The National Problem of Solid Waste Disposal* (1970), argues that in addition to air and water, both accepted and long-held arenas of pollution issues, solid waste represents a "land pollution" that is "inextricably linked with the other two" (7). Although unsurprising to both environmental planners today and especially so in light of the rich though largely

[10] The *Mobro 4000* was ship carrying a full load of garbage from Islip, New York to North Carolina that was turned away out of fears it contained hazardous wastes (Magoc 2011). See section 3.6.4 for a full explanation.

unsung history of solid waste management in the United States, solid waste as an issue was considered a near overnight development (Melosi 2000, 338). The problems that had been brewing during the seemingly stable years following World War II, as discussed last section, were exacerbated by continuing population growth (Melosi 2000, 339). The issues matched with the growing environmental consciousness in the U.S. would lead to a new federally-oriented attempt at solving the waste problem.

The air, water, land nexus of which solid waste was now a part of a growing body of national environmental legislation. The environmental movement of the 1960s and 70s has been widely studied and lauded by planners and policymakers; the passage of the Clean Air Act (CAA; 1963) and the Clean Water Act (CWA; 1972), along with the National Environmental Policy Act (NEPA; 1970), are behemoths in the sub-field. Solid waste management was not without its own landmark regulations, but they have been focused on much less substantially within the field of planning. Outside of crisis planning for hazardous waste sites like those subject to the Environmental Protection Agency's Superfund program, waste and landfills did not become the major sticking point in environmental policy that de-polluting air and water did. Nonetheless, the ability to recognize solid waste as a potential pollution issue more than only a nuisance was key to producing the most recent major shift in the way we deal with garbage.

3.6.2: Physical Expansion Spurs Regulatory Expansion: The EPA

As researchers began to understand the important nexus between pollution in air, water, *and* land, some states were prompted to initiate regulations that would help prevent pollution from incinerators (Melosi 1981, 197). Corresponding legislation such as the already authorized Rivers and Harbors Appropriation Act of 1899 was leveraged to require permits for anyone "to throw, discharge, or deposit, or cause, suffer, or procure to be thrown, discharged, or deposited...any refuse matter of any kind" and therefore anyone engaged in filling wetlands or any other waters considered "navigable" by the U.S. Army Corps of Engineers (33 U.S.C. §407).

Several pieces of landmark legislation emerged in this period of U.S. garbage history that were key to shifting the course of waste management, including the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970. President Lyndon B. Johnson called in 1965 for "better solutions to the disposal of solid waste" and the response from Congress was the Solid Waste Disposal Act (SWDA) of 1965 as part of amendments to the Clean Air Act (Melosi 1981, 199-200). Among other things, the SWDA would call for the federal government to take a leadership role in researching and provision of financial assistance, although the act mainly was concerned with the disposal side of solid waste management rather than the collection of the garbage (Melosi 1981, 200).

While not eroding local and regional authority over waste collection and disposal, the SWDA meant to provide resources to municipalities to take up a new wave of more environmentally-aware waste management. However, the SWDA was unable to define a single federal authority to oversee refuse and there was a dearth of data in the field (Melosi 2000, 352). Under President Johnson's direction, the National Survey of Community Solid Waste Practices was produced by White house staffers with help from a number of agencies, and it became the first study of its scope in the United States to attempt to address the data void (Melosi 2000, 200). No existing agency was interested in being the sole authority on the SWDA, as expanding their system boundaries to take on new compliance monitoring and potentially new blame without a corresponding increase in financial and labor resources would be highly unpopular.

If the 1960s prepared the U.S. for a change in course, 1970 was the year the wheel was turned. The first ever Earth Day was celebrated in the U.S. on April 22, 1970 (Melosi 2000, 363). The slogan for the first Earth Day in 1970 was the pithy "People Pollute," which was meant both in the sense that people litter and cause pollution, and that pollution is primarily caused by overpopulation (Kasun 1999, 218). In the mainstream of environmental activism in the United States at the time was the doomsday concept of a Malthusian overpopulation, fueled by Paul Ehrlich's popular book *The Population Bomb* (1968) (Kasun 1999, 218). However, this pessimistic attitude morphed into a new, more positive frame in the face of neoliberal mantras of rational individual choice in the Regan years and beyond.[11]

Critically for solid waste specifically, amendments to the Solid Waste Disposal Act were passed in 1970 as the Resource Recovery Act (Melosi 2000, 353). The Resource Recovery Act (RRA) changed the course of federal involvement in solid waste management from providing research assistance for new disposal technologies to actively promoting recycling and waste-to-energy efforts (Melosi 2000, 353). The RRA also included provisions for the handling of hazardous waste (Melosi 2000, 353). The federal guidance caused many states to begin creating or heavily expanding their own solid waste agencies; these agencies developed solid waste management plans to comply with the federal requirements set for funding (Melosi 2000, 353). The growing waste responsibilities of the federal government had difficulty finding an agency to house them, bouncing between agencies and temporarily settling in the Public Health Service (charged with municipal waste) and the Bureau of Mines (overseeing

[11] Neoliberalism "refers to the body of ideas that argues for the efficiency of markets and against state interference in social and economic processes" (Fainstein and Campbell 2012, 17). Neoliberal policies include those that further "privatization, deregulation, and decentralization" (Fainstein and Campbell 2012, 17).

industrial and mining wastes) (Melosi 1981, 201). The final thrust of the momentous year came in the creation of the Environmental Protection Agency (EPA) in the federal government, who took over the tasks begun with the SWDA five years earlier in addition to other sources of air and water pollution (Melosi 1981, 201).[12] Rather than attempting to shoehorn responsibility for solid waste into two separate agencies, the federal government resolved the conflict by creating a new agency in order to adapt to new conditions.

The carrot of federal funding for local and state demonstration projects led to an explosion in state legislation on solid waste, and what had once been a virtual wild west of disposal technologies with landfilling at the forefront came under scrutiny as well. By 1975 every state except Wyoming had enacted solid waste management statutes and they were in the process of drafting and approving one (Melosi 1981, 202). To aid solid waste decision makers in trying to comply with the new regulations, the EPA released a guide in 1974, with such helpful information as a flowchart of decisions from collection through to disposal (see Appendix C), tables comparing the economic feasibility of recovery and disposal options, and

---

[12] Although finding a home within the EPA may seem as though it could only be a boon for proponents of federal solid waste programs, the EPA's mandate to control pollution meant that the thrust of its waste efforts, even to this day, are in the handling of hazardous wastes that pose the greatest pollution risks. Municipal solid waste collection, disposal, and recovery programs can often face cuts ahead of hazardous waste programs (Melosi 1981, 201).

even a table explaining the potential advantages and disadvantages and political considerations for different options (Colonna and McLaren 1974).

3.6.3: Closures from Stricter Regulation and Growing NIMBYism

Subsequent reauthorizations of the act as the Resource Conservation and Recovery Act (1976; RCRA), and later the Hazardous and Solid Waste Amendments (1984), would add the “stick” to the previously available “carrots” of federal funding and research (Melosi 2000, 420). Somewhat of a misnomer, there was typically very little difference between open pits and piles of waste and the “sanitary” landfills that had steadily gained popularity in the U.S. after World War II. Sanitary landfills, often little more than a semi-frequent covering of earth, and their less-widely-accepted but still in use counterpart, incinerators, were both coming under fire from the environmental movement that blossomed during the time (Blumberg and Gottlieb 1989, 16-17). Declines in incineration had coincided with the rise in sanitary landfills, but a growing NIMBYism and greater understanding of the risks of leaching from landfills, as well as landfills’ visibility as symbols of the excesses of consumer culture all played a part in the reemergence of solid waste as an issue to be concerned about (Blumberg and Gottlieb 1989, 3-35). With the passage of the Clean Air Act in 1963 and its subsequent amendments, increased controls on incineration technology raised the already more expensive costs of burning trash well above the relatively cheap tipping fees required by sanitary landfills (Blumberg and Gottlieb 1989, 18). Scrubbers required by the 1967 amendments particularly hit incineration hard and within five years over a hundred plants had been closed with many more operating at diminished capacity rather than creating too many emissions (Blumberg and Gottlieb 1989, 29).

Similarly, regulations stipulated for landfills to literally clean up their acts. Into the mid-1970s, ninety-four percent of land disposal sites surveyed did not “meet the minimum requirements for a sanitary fill” and many more were still unauthorized and operating under that table nationwide (Melosi 1981, 218). Especially in the 1984 amendments to the Resource Conservation and Recovery Act posed caused issues for many currently operating sanitary landfills. These amendments stipulated that those open dumps and landfills unable to meet new technological requirements (meant to prevent groundwater contamination and open burning of refuse) would need to close and a strict timeline was established (Blumberg and Gottlieb 1989, 35). The 1984 amendments, best known for their stipulation that the EPA take a “cradle to grave” approach to monitoring and mitigating hazardous waste impacts, closed most open dumps and placed strict regulations on sanitary landfills, including size and location of landfill sites (Melosi 2000, 420). By removing “the subsidy of the cheap landfill,” the rules promulgated based on the RCRA attempted to shift the burden of the solid waste crisis onto producers who generated the waste by increasing the costs and therefore the tipping fees for dumping (Melosi 2000, 421). This strategy is one of increasing the cost of doing business without directly taxing corporations, in effect nudging those companies willing to meet regulations with a carrot rather than punishing all companies with a stick. Combined with other federal “watchdog” environmental legislation, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), operators of sanitary landfills, both public and private were being forced more and more to take responsibility for the externalities they created (Melosi 2000, 421). This resulted in the closure of a huge number of smaller landfills, primarily local businesses and municipal landfills for towns and suburbs (Melosi 2000, 421). “Landfill regulations were increasingly tied to environmental considerations” and were frequently the target of activists such as Greenpeace (Melosi 2000, 37-38).

National news media began publishing articles warning that landfills were running out of room, and an oft-cited EPA study warned that at least one-third of municipalities would run out of space by 1992 (Shabecoff 1987). Lingering concerns about landfill capacity intensified as a seemingly alarming number of landfills began closing in the following years. In some areas of the country, such as in dense agglomerations like the Northeast U.S., faced an actual disparity between waste generation and landfill capacity, but the national anxiety on how to address the solid waste "crisis" was palpable (Shabecoff 1987, 35-36).

3.6.4: Municipal Solid Waste in the Public Eye: Voyage of the *Mobro 4000*

Often cited is the infamous *Mobro 4000* carrying Islip, New York's municipal solid waste to be tipped in North Carolina (Katz 2002, 1). Carrying 3,100 tons of waste, the barge spent months of 1987 moving from port to port—after North Carolina declined to take the waste, the barge was turned away in Louisiana, Alabama, Mississippi, Florida, Mexico, Belize, and the Bahamas (Melosi 2000, 395). The *Mobro 4000* eventually returned to New York and after having its cargo briefly detained, the refuse was dumped back into the local landfill that its owner had originally hoped to avoid based on its higher tipping fees (Magoc 2011). The story was widely covered in the mainstream media internationally, and the message was clear: the United States had a flaw in its approach to waste management.

In a nearly identical though less well-publicized incident in 1985, the *Khian Sea* departed Philadelphia in the fall carrying ash from its two municipal incinerators (Rathje and Murphy 2001, 180). The *Khian Sea*'s load of ashes was originally going to shipped to the Bahamas, and later destined to be used in "a road-building project along Panama's fragile wetland areas" but an EPA report on the toxicity potential of the waste resulted in both countries withdrawing landing rights for the ship (Müller 2016, 16). The ship went on to spend 27 months at sea searching for somewhere to dump its ashes (Müller 2016). Mysteriously, the ship "reappeared" in 1988 in Singapore under a new name, *Pelicano*, and without its cargo; the captain refused to say where the waste had been dumped (Rathje and Murphy 2001; Müller 2016).

The *Mobro 4000* and the *Khian Sea* brought the attention of a wide public to the difficulties facing cities without nearby inexpensive land to dump their own wastes. Not only did it "uncover" a hidden "crisis," it furthered an ulterior media motive that large cities (especially New York) were poor performers when it came to meeting citizen service needs, an argument that was levied against New York time and time again during the 1980s (Melosi 2000, 395). It is telling that the matchsticks that set off the obsession with a waste crisis were end-of-the-line mega-barges with nowhere to turn. The focus on disposal as the step necessary to solve the garbage crisis, rather than a reduction in production, has been a typical response from engineers looking to find technological fixes (Blumberg and Gottlieb 1989, 5).

Many tycoons like Judd Alexander in *In Defense of Garbage* (1993) recalled the garbage crisis as being a capacity, rather than a discards issue and cited statistics such as that "forty percent of the nation's landfills [had] closed since 1978 and 40 percent of the remaining operating sites [would] reach capacity by 1996"

(Alexander 1993, 21). This is a typical argument from those who lobby against source reduction of material (such as by reducing the raw virgin materials mined before they ever become products consumers discard), those with financial interests in the efficient management of garbage rather than a society that is zero-waste.[13] Those with an eye to their own profits, such as "throwaway industries" like the beverage container industry, emphasize aspects of solid waste management other than the fundamentally broken metabolic rift. These opponents instead cite growing "NIMBYism" and lack of individual education as more critical issues in the ballooning solid waste issue (Alexander 1993, 21-22).

3.6.5: The Landfill "Crisis" Sets the Stage for Widespread Recycling

Cultural touchstones have a function in times of heightened insecurity, bringing important light to issues that often seem as though they are not personal or pressing as well as signaling that changing conditions could provide new opportunities in the marketplace. The two other major pillars of sanitary services,

---

[13] Judd Alexander is a fine example of such an opponent to the zero-waste movement. He was formerly an Executive Vice President for the American Can Company, a major tin can manufacturer often plagued by claims of trusts and monopolies. Packaging manufacturers have been some of the most vocal opposition to reuse strategies, evidenced most spectacularly in the decline of "bottle bills" and returnable bottles (Blumberg and Gottlieb 1989, 237-240). Additionally, Alexander served as Chairman for Keep America Beautiful, Inc., a nonprofit antilitter association with ties to the beverage container industry and a focus on individual responsibility instead of packaging manufacturer responsibility (Melosi 1981, 213-214).

water supply and sewerage, were (and are) facing the same level of uncertainty through their own crises of deteriorating infrastructure (Melosi 2000, 395). However, waste is the sort of pollution problem that affects many other problems, and any pollution problem can easily also turn into a waste management problem (Melosi 2000, 397).

Nonetheless, it is critical to keep the fanfare in perspective. Some areas of the country, especially large older urban centers on waterbodies, did find themselves with dwindling landfill space and faced difficulty siting new landfills due to NIMBY protests (Melosi 2000, 396). Publications from the period stress this, noting that while “landfills have become a quick solution to waste disposal,” space in the Northeast was becoming scarce (Long 1989, 5). A disproportionate rise in tipping fees in the Northeast U.S. confirmed that the squeeze on space was being felt; the “cumulative cost of disposal, environmental risk factors, management problems, compliance with regulations, and the squandering of resources” were combining to make the sanitary landfill much less attractive (Melosi 2000, 406).

But, as pointed out by numerous proponents and critics with the benefit of hindsight, we have not yet been buried in garbage. In the foreword to a reprint of their book, *Rubbish!* (1993), authors William Rathje and Cullen Murphy noted:

> “Ten years ago the fear was raised that as a nation we were ‘running out’ of landfill space. Today most people know that there is landfill space aplenty; indeed, some authorities now raise the specter of a ‘glut’ of landfill space” (Rathje and Murphy 2003).

In an earlier quote in *Atlantic Monthly*, William Rathje (1989) points out the perhaps more important reason that we may have a crisis of garbage in the United States, and it is not that we are likely to be buried in our own waste:

> "The use of the word 'crisis' in these contexts has become routine. For all the publicity, however, the precise state of affairs is not known. It may be that *the lack of reliable information and the persistence of misinformation constitute the real garbage crisis*" (99; emphasis my own).

It appears that we still have the same issue nearly three decades later, with little idea of the composition of our existing landfills, only a small understanding of how materials biodegrade, and only a marginally better handle on such hazards as groundwater leachate and methane (Melosi 2000, 403). And although some business-minded critics have spun a different story about the waste crisis, furthering their interests by downplaying it, the pessimistic characterization that follows many environmental arguments can come into play when a reported crisis turns out to be less dire than anticipated. The alarmist, "sky is always falling" narratives that distinguish the environmental push beginning in the 1960s and continuing as a staple throughout the end of the century do not stick well with the public (Alexander 1993, 168).

3.7: Neoliberalism, Individual Onus, and Doubling Down of Throwaway Culture

This section will focus on the relationship between neoliberalism and the shift away from governmental responsibility for MSW planning onto the individual consumer. I will also discuss the effects of the core-periphery in terms of environmental racism and resulting efforts during the late twentieth century for environmental justice.

3.7.1: Recycling as the New "Solution" to Municipal Solid Waste

Recycling, having become quotidian across most U.S. municipalities, has proved not to be enough to solve all the questions that the complexity of solid waste management demands. The 1980s were the "takeoff stage" for recycling, now no longer a low-tech method of source reduction organized by small grassroots outfits, an entire sub-market has emerged to serve the programs that began popping up (Melosi 2000, 411). In a rare political situation with nearly no downside, politicians could support recycling in their communities, increasing favor with constituents that had read about the horrors of landfills and incinerators, while simultaneously not going after the largest segment of waste producers in the U.S.: source extractive industries and agricultural interests (Melosi 2000, 413). The moralistic tone of early progressive sanitary reformers returned as people across the United States rushed to start handling their own garbage, sorting out those items that could be recycled (Melosi 2000, 415). John Tierney (1996), in a controversial article in the *New York Times*, wrote that the fervor over recycling approached a "Transcendental" act of "moral redemption."

For all this fervor, though, we have seen little dent made in overall waste generation statistics. As discussed in Chapter 1, recycling efforts account for a substantial portion of the waste generated, but the average U.S. citizen does not generate any less waste than they did fifteen years ago. Recycling has made a dent in streams of post-consumer material in MSW management, but has done little as an overarching repair for the metabolic rift our cities face.

3.7.2: Neoliberalism and Municipal Solid Waste Management

So instead of major overhaul, the neoliberalism rampant in society today focused its solution to the waste crisis in small, individual actions to conserve resources. Books such as *50 Simple Things You Can Do to Save the Earth* became core texts across childhood education and espoused the ideology that conservation is the key to environmental, and especially waste, crises (Alexander 1993, 178). The League of Women Voters put out several "handbooks for citizens," covering the ins and outs of nuclear waste, plastics, and garbage (League of Women Voters 1993a; 1993b; 1993c). Antilittering organizations like Keep America Beautiful distributed white papers and full reports like *The Role of*

Recycling in Integrated Solid Waste Management to the Year 2000 to explain the benefits and limitations of recycling as a panacea for disposal woes (Franklin Assoc. 1994). How-to guides to setting up local recycling programs and explaining in detail the challenges of specific materials, such as Jennifer Carless' *Taking Out the Trash: A No-Nonsense Guide to Recycling* (1992), are reminiscent of the work of early civic reform organizations, but instead focusing on the environmental impacts rather than the health and nuisance issues of the previous century.

In fact, the most recent largescale civic activity regarding solid waste management is not the major environmental activism in the 1960s and 70s, but the indoctrination of recycling and the "Three R's." Schoolchildren and adults alike were told that their collective decisions to conserve energy and resources through turning off lights and recycling would be what made the difference. In much the same rational, collective externalizing and aggregating of individual preferences, neoliberal economic theory stresses that "cultures, ideology, feelings of pride or honour, familial ties, paternal or maternal care, voluntarism or altruism are not of interest" (Wilson 2012, 362). Neoliberal policies favor minimal regulation and a renewed effort at laissez faire markets, which aggregate consumer preferences through individual actions. This focus on individual responsibility for change parallels the rise in education campaigns focused on small actions that can help the environment. The prevailing approach is highly neocivic, pushing the responsibility off of producers and focusing only on end-of-pipe solutions that consumers can take. “Substantial progress has been made in increasing energy efficiency,” in the United States, but the neotechnic advances have been to the benefit of the predominantly paleotechnic private sector rather than the environment (Harvey 2005, 173). Specifically, in regard to planning, pro-growth neoliberal policies have caught local municipal planners between “pressures on...governments to promote urban economic competitiveness” and “state and national policies that contribute to...rapid population growth” (Wilson 2012, 361). These pressures have often forced planners to ignore any community participation that presents an obstacle to development, which places democratic processes in jeopardy and typically results in the silencing of marginalized groups and stakeholders without economic priorities (Wilson 2012, 364).

Another dimension of neoliberalism’s characterization of solid waste is that it is a crisis that can only be solved through individual action, as opposed to civic action or state and federal regulation. This aspect comes from the neoliberal mandate for deregulation in industries and markets. While individual efforts should not be discouraged or discounted, the magnitude of our solid waste management issues in the United States calls for action at a larger scale, either regionally or federally. By suggesting that the problem is for individuals to handle, neoliberalism diverts attention and blame from producers of waste in industries such as mining and agriculture, which constitute a larger portion of overall waste generation nationally.

Though such popular and trade publications like these and numerous others push awareness of a critical issue that needs addressing, without holistically planning for the entire resource system—from first production through either disposal or circular return to the system—these "simple" things will never be able to make much of a dent. Our society currently employs a frame where waste, which is understood to be just another part of life, is simply a consequence of modernity.

3.7.3: The Core-Periphery, Environmental Racism, and Late Stage Capitalism

Considering the metabolism of cities also necessitates understanding the mechanisms and power structures that privilege dominant groups, both within communities and among nations. Core-periphery studies contends that these power structures manifest wealth and poverty spatially in a privileged *core*, which is "wealthy and possess[es] the means of production," and a disenfranchised *periphery*, which is "poor and dependent on the core for the means to produce" (Graves 2006, 62). The approach of core-periphery in economic development studies can be applied at every scale, from local to global (Hanks 2011). Marxist economists deploy core-periphery by asserting that "the accumulation of wealth in the core is a product of the exploitation of resources obtained from the periphery" (Graves 2006, 62).

As Harvey observes, "the flow of population and affluence back into the city centers [from the hinterlands] is marked," creating "a complex checkerboard of segregated and protected wealth in an urban soup of equally segregated impoverishment and decay" (Harvey 2000, 405). In the United States, these localized pockets of segregation have historically been created through a complex interaction of policy, financial and insurance mechanisms, racial segregation, zoning, and restrictive covenants (Tretter 2012). Today, negative environmental effects coming from pollution that disproportionately affect racial and ethnic minorities are known as issues of environmental racism. Environmental racism is the theory that "exposure to environmental risks is significantly greater for racial and ethnic minorities than for nonminority populations" (MacLean 2011, 605). While many studies have quantified these impacts, the EPA has concluded that "there is not enough data to draw such broad conclusions" (MacLean 2011, 605). The environmental justice movement has grown up in response to these disproportionate impacts as well as the "concern that traditional environmentalism does not recognize the social and economic components of environmental problems and solutions" (MacLean 2011, 606).

The beginnings of the environmental justice movement in the United States are intimately tied to the history of solid waste management. As part of a lawsuit in which a “middle-class African American community in Houston” was seeking an injunction to stop the siting of a landfill, Robert Bullard compiled data on the locations of landfills and racial characteristics of surrounding neighborhoods (Magoc 2011, 127). At the time in 1978, though African Americans accounted for only 25% of the population of the City of Houston, 100% of landfills in the city were located in majority black neighborhoods (Magoc 2011, 127). This early attempt to quantify the disparate impacts of solid waste management “marks the beginning of the environmental justice movement,” even though the term *environmental racism* would not be coined for nearly a decade (Magoc 2011, 127; MacLean 2011, 605).

Many other prominent examples show the intimate ties between the social movement and solid waste management. In predominately black Warren County, North Carolina, a “campaign of civil disobedience” took place in the early 1980s, during which more than 500 people were arrested while protesting the siting of a landfill for soil contaminated with polychlorinated biphenyls (PCBs) (Magoc 2011, 127). A report later published in 1983 by the U.S. General Accounting Office in response found that in the southeastern U.S., three out of four communities with landfills were predominately African American (Magoc 2011).

As just mentioned, core-periphery dynamics are at play at a multitude of scales, including worldwide. Following Harvey (2006) and his theory of uneven development, capital is accumulated in cycles in a capitalist economy, disrupting social and ecological systems in its blind pursuit of profit. Profits end up accumulating in some regions while other regions are violently plundered for resources (both physical and human) to feed the profits of those in power. But because earth is a bounded system, this neo-colonialization of developing countries' resource stocks and the resultant environmental degradation they experience cannot continue *ad infinitum*. Climate change is just one example of these globalized effects in a bounded system, and, because solid waste management practices exacerbate it by contributing to greenhouse gas emission, a reframe of waste will be necessary.

Reframing waste will first entail naming the frames that have operated within and contributed to the solid waste situation in which we find ourselves currently. Before I synthesize findings of frames of solid waste management from my historical research, however, I will first address several critiques of one of the authors on whom I have relied heavily, Martin V. Melosi, in an attempt to round out the historical narrative where Melosi' own frame has left his scholarship silent.

3.8: Critiques of Melosi

Martin V. Melosi is the preeminent scholar on urban infrastructural history in the United States, having published extensively on waste management, water delivery, pollution, energy markets, and automobiles' effect on the environment. His scholarship is grounded in thorough archival research and his works provided me with the starting point of my research into the history of solid waste management in the U.S. Although Melosi is instrumental in shaping my thinking on the subject and I have heavily relied on his work throughout this chapter (especially *The Sanitary City* and *Garbage in the Cities*), I would like to briefly address some critiques of his mode of historic narrative, both of which have to do with challenging a "great man" narrative. The following two sub-sections explain and expand on these critiques.

3.8.1: Feminist Critique of Melosi

The first major area of critique for Melosi's work comes to us from a feminist planning perspective. Mainstream planning scholarship, and especially planning histories, integrated the critiques of feminist scholarship late as compared to sister fields in the social sciences, such as sociology and geography (Fainstein and Servon 2005). Planning scholars only started expressing concern about the lack of examination of gender biases and omissions starting in the late 1970s (Fainstein and Servon 2005). Early work in planning incorporating feminist theory focused on women as a hidden user group, as an *object* (e.g., Rosenbloom 1978). However, within studies of the history of planning, scholarship that centers female planners and their work as *subjects* has been especially absent. Ignoring gender in the history of planning erases the important contributions of women planners and, as Sandercock (1998) asserts, makes a political decision about who is and is not a planner and what is and is not within the boundaries of planning (1998). Fainstein and Servon (2005) argue that

> "using gender as a category of analysis...provides new perspectives on old questions, redefines existing issues in important ways, and makes women visible not only as subjects of planning but also as active participants in planning and policy-making processes, albeit often in nontraditional ways" (4).

Melosi's history of urban infrastructure and solid waste management has many of the characteristics of what Sandercock (1998) calls a "great men" account of planning history (3). Rather than a critical examination of the effects of "power/knowledge/control" in planning or the "ideology, class, gender, or ethnic origins or biases of planners," Melosi is primarily writing a congratulatory and heroic tale of planners triumphing over "the evil world in which 'he' must operate" (Sandercock 1998, 4). Evidence of Melosi's focus on the efforts of a few "heroic" men can be easily seen in the index of his major synthesis work, *The Sanitary City* (2000). There is an entry for "women" (none for "men," of course) and the topic appears only in six pages of the 550 plus page book (Melosi 2000, 578). "Women," for Melosi, are relevant to the rise of sanitary planning only in relation to their involvement in civic groups (pages 106-107 and 183-184), in the environmental movement (369), and health reform (184-185).

The treatment of individual male and female "heroes" of sanitary planning follows a similar disparity. Melosi mentions sixty men individually by name in the index to *The Sanitary City*, and just three women receive the same individualized attention (Melosi 2000, 567-578).[14] By highlighting for entire chapters the contributions of men like Edwin Chadwick and George Waring, Melosi reinforces the problematic assumption that planning history is one of several great men taking on the evils and problems of the world.

Further, it is not that there are no women to speak of in the history of solid waste management. Incorporating the work of settlement house founders such as Jane Addams, is in many ways low-hanging fruit, since much is known about her work already and she herself was a prolific autobiographer and chronicled the efforts of Hull House extensively. Indeed, Melosi does discuss Addams in an

[14] The three women that Melosi calls out individually are Mildred Chadsey, Sylvia Lowrance, and Christine Rosen. Chadsey was the commissioner of housing and sanitation for the city of Cleveland and coined the term "municipal housekeeping" (Melosi 2000, 184). Lowrance was the director of the EPA's Office of Solid Waste (Melosi 2000, 396). Rosen is a historian and associate professor at the Berkeley Haas School of Business specializing in corporate environmental history and pollution regulation in the U.S. (Melosi 2000, 9).

earlier work of his, *Garbage in the Cities* (1981), but the coverage is a mere five or so sentences scattered across four pages.

If the aim of this type of historical narrative is to showcase the agency of individuals in order to push back against, for example, the economic reductionism for which some Marxist scholars are critiqued, then the same individual "heroism" that Melosi paints Colonel George E. Waring with could be applied to female "heroes" as well. Where in Melosi's work is Catherine Bauer, or Edith Elmer Wood, or Florence Kelley, or Mary Simkhovitch, all integral in the settlement house movement and later public housing reforms that drove much of the grassroots actions in MSW management (Corburn 2009; Carson 1990)? What about Dr. Alice Hamilton, not only a reformer with Addams' Hull House who was instrumental in demonstrating that plumbing deficiencies led to a 1902 typhoid outbreak in the neighborhood, but who also went on to become a prominent occupational health and industrial toxicology researcher (Addams 1910; Carson 1990)? What about more recent work from local activists, like Jazzie Collins, Margaret Gordon, and Kami Pothukuchi in the San Francisco Bay area (Corburn 2009)? Melosi does not lack prominent women to focus on in his chronicling of individual triumphs for MSW management, and yet their stories are either not included or the subject of a few passing sentences along the way.

3.8.2: Insurgent Critique of Melosi

The second critique I would like to bring against the infrastructural histories of Melosi, an insurgent critique, is related to my feminist critique. Melosi's scholarship focuses heavily on the "official" and institutional actors that shaped solid waste management in the United States. Holston (1998) describes an alternative history to the state-sponsored one that we are most familiar with. He uses the term "insurgent" to challenge the "doctrine...that the state is the only legitimate source of citizenship rights, meanings, and practices" because studying planning history in insurgent spaces can open us up to a new realm of possibilities (Holston 1998, 39).

As Sandercock (1998) notes, planning history has been rife with the celebration of the institutionalization of the profession, with "an obvious collective self-justificatory motive at work" (4). And if planning history only concerns itself with the profession, it excludes "whole realm of community-driven and community-based planning" as irrelevant (Sandercock 1998, 7). The work of "recovering" the contributions of grassroots level community planners "demonstrates the capacities of ordinary people to plan on their own behalf" and should not be left out of planning histories (Sandercock 1998, 10).

Melosi, with his focus on many heroic men who shaped solid waste management in the U.S., has missed many critical contributions from these “ordinary people” who worked to better their own communities. While he considers community reform organizations such as the Juvenile Street Cleaning Leagues and the Ladies Health Protective Association, he only does so in their relation to his biggest of important male planners, Colonel George E. Waring. These grassroots organizers that Melosi mentions were sanctioned by the state authorities, but what about citizens who practiced a more “insurgent” form of solid waste planning?

Take for example, community groups such as the Young Lords in New York City, a group of Puerto Rican activists in East Harlem (Corburn 2009). Originating in Chicago in the 1960s, the Young Lords began as a Puerto Rican turf gang and, after one of its founders Jose Cha-Cha Rodríguez met Fred Hampton (a leader of the Black Panthers in Chicago) morphed into a radical socialist group (Santos-Hernández 2008, 1421). Similar to the Black Panthers, the Young Lords’ actions included “free breakfasts, health care services, and clothing for community residents” (Santos-Hernández 2008, 1421). One of the group’s four major “offensives,” in New York, the Garbage Offensive, came in 1969 (Whalen 2006, 816). When the sanitation department refused to collect “El Barrio” neighborhood garbage for weeks, the Young Lords “piled the trash in the streets, forcing the city to remove it” (Corburn 2009; Whalen 2006, 816). They were fighting against unequal treatment of minorities by the sanitation department and demanded more frequent collection service (Santos-Hernández 2008, 1421). The Young Lords are the embodiment of "insurgent planning." As Corburn (2009) writes:

> "The Young Lords *combined local knowledge with professional techniques* to address health disparities in their neighborhood and showed that contrary to dominant professional beliefs at the time, urban neighborhoods were not places of total disorder requiring 'expert-derived rational designs' imposed on them without their consultation" (56-57; emphasis my own).

The Young Lords were active in New York, the city Melosi most heavily focuses his evidence on, into the early 1970s, and Melosi's book *Garbage in the Cities* was not published until 1981. Yet even for its all of its direct applicability to Melosi's work, the Young Lords and their Garbage Offensive make no appearance in any of his scholarship. How is it that Melosi failed to recognize the importance of a grassroots organization like the Young Lords? It could be because the Young Lords were not above resulting to violence to obtain their social justice goals (Santos-Hernández 2008, 1421). It could be because, as Holston (1998) contends, their insurgent planning practice subverts the state agenda, and correspondingly, the professional planners that Melosi holds up on a pedestal. It could be for any other number of reasons, be they more or less innocuous. However, what is clear is that the focus on governmental agencies and key heroic men in Melosi's history does not leave space for the insurgent planner to become a relevant actor.

3.9: Summary of Municipal Solid Waste Planning Frames

The history of solid waste management in the United States reveals several frames that planners have used to approach their work. In the following sub-sections, I will summarize the frames found in my review of the history of MSW management. Three distinct frames, the *rational positivist*, the *grassroots communitarian*, and the *insurgent radical*, have affected the ways which we work in solid waste. Table 1 summarizes the defining characteristics of these three frames. Each frame has both shortcomings and advantages that, when considered together point to the need for reframing waste as we move forward.

TABLE 1: MSW MANAGEMENT FRAMES

	Rational Positivist	Grassroots Communitarian	Insurgent Radical
Definition of problems	Problems are discreet and planners can address problems in insolation from one another	Problems are linked and these linkages should be understood	Problems are completely intertwined with one another and cannot be separated
Definition of solutions	The "right" solution can be found	There are "right" solutions that together can be found	Rather than looking for the "right" solution, we should try everything that has positive impacts
Attitude towards intervention	Technology advances will be the answer to our problems	Coalition building will be the answer to our problems	Solidarity and social justice will be the answer to our problems
Attitude towards context	What works for one city will likely work for all cities	We can apply aspects of what works for one city to another	What works for one city might not work for another city
Attitude towards decision making	The state has a responsibility to address urban problems, and therefore state-sponsored planners are the experts who should make decisions	Citizens have a responsibility to address urban problems, and therefore community members should work with authorities to make decisions	Citizens have a responsibility to address urban problems, and therefore community members are the experts who should make decisions

As Sandercock (1998) states, different frames represent the

> "transformative and repressive powers of state-directed planning practices and their mirror image, the transformative but also repressive potential of the local, the grassroots, the insurgent" (27).

Working to integrate these disparate frames into a useful alternative is the objective of the second half of my project, and the subject of chapters four and five. The rest of section 3.9 that follows will provide answers to research questions Q1 (What frames has the field of planning employed in MSW management?) and Q2 (Are there unintended consequences to the frames previously utilized that have contributed to our current MSW problem?).

3.9.1: The Rational Positivist Frame

There is a long history in planning of using the rational positivist frame when determining problems and devising interventions to address those problems. By *rational positivist*, I mean planning in which efficiency and technological solutions are front and center. Healey (2012) describes rational to mean "both a form of deductive logic, and the use of instrumental reason as a form of argument, drawing upon scientific analysis (226). "Positivist" has a similar meaning, being a "belief in a reality 'out there' that can be fully known" (Groat and Wang 2013, 77). I purposely chose to use a joint naming for this frame in order to emphasize how a frame affects both how you respond to problems and how you view the world—your ontology. *Rational* refers to the types of research conducted by those utilizing this frame, while *positivist* characterizes beliefs about reality and knowledge production held by those utilizing this frame. Commonly in planning, rational positivists are synonymous with "technocrats," to use Stanley's term (2017). Stanley defines a technocrat as having a "belief in 'metrics' and quantitative data as the legitimate responses to policy issues, legitimate because of [its] supposed 'neutral' and ‘apolitical’ character” (Stanley 2017, 10). In this section, I first outline several characteristics of the rational positivist frame, and then discuss where we have witnessed *rational positivism* in MSW history and the impact the frame has had on solid waste planning.

Rational positivist planning can be recognized by the following characteristics of problem identification and problem solving:

1. Problems are discreet and planners can address problems in insolation from one another.
2. The “right” solution can be found.
3. Technology advances will be the answer to our problems.
4. What works for one city will likely work for all cities.
5. The state has a responsibility to address urban problems, and therefore state-sponsored planners are the experts who should make decisions.

3.9.1.1: Problems as Discreetly Addressable

Solid waste management has often been seen as an issue to address separately from other urban concerns. A prominent example is that until William Small’s book, *Third Pollution* (1970), solid waste was not widely considered as an area of pollution concern. While the 1960s saw a regulatory response to pollution in the Clean Air and Clean Water Acts, where was (and is?) the “Clean Land Act?” Attempting to address solid waste issues separately from other urban problems like air pollution led many rational positivists to endorse incineration plants as a permanent way to dispose of waste. Yet the pollution caused by incinerators was left unchecked. In essence, rational positivists who attempted to solve the waste problem in isolation with incineration did not “solve” their solid waste issue so much as turn it into an air pollution issue instead.

Solving problems in isolation also led rational positivists to advocate for recycling as a solution to the MSW troubles of the U.S. in the 1980s and onward. While making a small dent in waste disposal figures, recycling did nothing to address other issues such as untenable levels of consumption, a consumerist society that dictates obsolescence through fast fashion, or the large amount of waste created in the production side of our metabolic cycle. Rational positivists choose to look at their solid waste problems within discreet system boundaries, which in turn prevents a holistic view that has potential for synergistic solutions that address many aspects of urbanization.

3.9.1.2: Finding the Panacea

The rational positivist frame can be seen surfacing wherever someone is looking for “the” one solution to solid waste management. It happened in the early twentieth century, with cities trying to move to exclusively incineration, reduction, landfilling, or even feeding their waste to swine herds. Although many cities would have been better served by some combination of disposal techniques, engineers and planners who ascribed to the rational positivist frame were stuck debating over which technique was the right one, the best to solve solid waste concerns.

This current of the rational positivist frame reemerged in efforts to recycle in the 1980s and 1990s, when the movement reached an almost transcendental following. Recycling, however, has been shown to have only made a reduction in our waste disposal into landfills. Today, most scholars across fields and frames agree that recycling alone can never fully alter our production and consumption cycle from a linear to a circular one. When rational positivists narrowly seek one solution to solid waste, they can easily miss the possibilities of other secondary technologies that might appropriately complement their primary focus.

Even if such a panacea to solid waste issues could be found and implemented, it would not make for a resilient or sustainable community. Redundancy, found frequently in ecological communities, is a key characteristic of resilient communities, useful because it increases the ability to withstand shocks from outside the system (Orr 2002). The rational positivist frame, following Enlightenment traditions that support the notion of man as ruler of nature, misses this key cue from natural design.

3.9.1.3: Technology as the Answer

Rational positivists view the world as an entity that can be scrutinized through the scientific process in order to understand reality. Technology, is therefore, considered to be the application of pure science and the answer to making changes in the world. Rational positivists have historically looked to technological advances to solve solid waste management problems. However, though technological innovation has undoubtedly addressed some of our issues, it has made many others more difficult to handle.

Technology has made waste collection many times more efficient than when horses drew carts through neighborhoods. Trucks today have sensors that determine the weight of loads, and soon we may see widespread rollout of smart dumpsters that can alert haulers to pick them up just as they get full. However, all of the technological advances have been unable to get curbside stream confusion/contamination percentages lower, or waste generation amounts lowered. Waste management is a sociotechnological system, and forgetting or ignoring the first portion to focus on the latter will never produce a complete transformation for the better.

3.9.1.4: Transferability of Methods

Following the scientific tradition, methods are considered to be universally applicable by rational positivists. Laboratory conditions are highly controlled with no variable unaccounted for in an experiment. Rational positivists, while they recognize that real conditions are not as clean cut as laboratory conditions, still adhere to a belief in universal applicability of results and derived technologies.

In my research, universal designs have been losers when it comes to solid waste management. Waste stream composition varies across countries, regions, cities, neighborhoods, and households based on a variety of socioeconomic factors such as income level, population size, density, education, life expectancy, etc. (Vieira, et al. 2017). When U.S. engineers implemented European-designed incinerators, the differences in waste composition caused technologies to not perform as well as expected. When the northeast U.S. experienced a crunch for landfill space, the Southern, Midwestern, and Western states had more than enough land available to continue the process unabated. Time has shown that technologies devised in certain contexts will not address solid waste as well in dissimilar contexts, and this is something that rational positivists will need to understand in order to effectively manage solid waste in the future.

3.9.1.5: Professionals as Expert Decision Makers

In a rational positivist frame, the planner is "merely a technician of means committed to the values of scientifically-based and rationally-deduced policy choices" but "neutral as regards ends" (Healey 2012, 227). Evidence for this frame is quantifiable and reproducible, and decisions are made apolitically and without value judgement. Therefore, it stands to reason that a rational positivist sees the decision making, as a role for the expert as well.

When professionals have made solid waste decisions without community engagement or consent, the results can be disastrous. Evidence of these failures come from Love Canal, the *Mobro 4000*, and any number of other environmental justice actions that have occurred in U.S. history (Taylor 2014). Community members are more likely to have hyper local knowledge that can positively inform decision making processes, and planners that do not pay attention to or value this input leave themselves and their decisions vulnerable to vehement push back from communities. Further, rational positivist planners who ignore local knowledge may be missing out on coming up with innovations that could better address specific community concerns.

3.9.1.6: Advantages of the Rational Positivist Frame

All of this is not to say that there are no advantages to rational positivism. The following two advantages of the rational positivist frame should be incorporated into the reframing of waste moving forward: its methodical interrogation of symptoms and its willingness to develop and experiment with new technologies. Both of these aspects can lead to a beneficial reframing of solid waste as a resource.

Without thorough analysis of solid waste problems (e.g. waste stream characterization, material degradation properties, etc.), we will not be able to address the risks of our current metabolic rift or begin to balance the material consumption and production flows of society. As Rathje (1989) noted, “it may be that the lack of reliable information and the persistence of misinformation constitute the real garbage crisis” (99). Rational positivism helps address the information gap of solid waste, and there will always be a need for the types of knowledge this frame generates. People are notoriously unreliable in self-reporting waste generation, so any methods that rely heavily on qualitative data are not going to be reliable enough for planners or communities to base their decisions solely upon (Rathje and Murphy 2001).

Finally, while rational positivists have previously shown an over-reliance on technical solutions, the importance they place on technological innovation and testing will help planners, designers, and engineers develop the next generation of solid waste management technologies. Our waste generation as a country has plateaued without decreasing for over a decade, and we still rely on versions of technologies that were developed the better part of a century ago (e.g., sanitary landfills, incinerators). New technology, though not the whole solution, may be able to further demonstrate waste's value as a resource rather than simply a nuisance or hazard.

3.9.2: The Grassroots Communitarian Frame

Grassroots communitarian planning is apparent throughout the history of solid waste management in the United States, and has been integral to major advances in solid waste management. Most *grassroots communitarian* framed planning has been carried out by civic reformers and environmentalists involved in recognized community or non-profit organizations. By grassroots, I mean “voluntary organizations” that “serve as watchdog[s] and put pressure on the regulatory process...rather than advocate new policy” (Owen Gardner 2011, 386). And by *communitarian*, I am referring to the ontology which values ties to one’s community as of the upmost importance, and sees “emancipation and self-realization as a collective rather than individualistic concern” (Harvey 2006, 125). Fusing these two words together to name this frame reinforces my assertion that the grassroots communitarian frame is both about how groups believe they can be most effective (*grassroots*), and about how individuals believe the relationship between self and group ought to be (*communitarian*).

Grassroots communitarian planning is exemplified by the following characteristics:

1. Problems are linked and these linkages should be understood.
2. There are “right” solutions that together can be found.
3. Coalition building will be the answer to our problems.
4. We can apply aspects of what works for one city to another.
5. Citizens have a responsibility to address urban problems, and therefore community members should work with authorities to make decisions.

3.9.2.1: Problem Linkages and Complexity Theory

Grassroots communitarians have, in relation to solid waste management, primarily adopted a stance on problem definition that recognizes the linkages between issues and futility of addressing these linked problems in isolation. Following complexity theory, according to Lanham et al. (2016), “helps one view sustainable development not as a goal that can be reached through the achievement of balance, but as a dynamic process of continuous evaluation, action, and re-evaluation" (49). Complex systems are nonlinear, co-evolving, and uncertain for grassroots communitarians (Lanham, et al. 2016). It is this through this understanding that grassroots communitarians choose to approach problems holistically, believing that an intervention in one part of the system will necessarily result in ripples through other parts of the system.

Environmental justice work in solid waste is a prime example of this characteristic of the grassroots communitarian frame. When approaching systemic racism in the landscape, these activists have not separated concerns of pollution, health risks, and solid waste from one another. Instead, as in Houston and Warren County, NC, grassroots communitarians highlighted solid waste among a number of other concerns and injustices and fought for solutions that addressed all of their concerns in tandem.

It is important to note a common criticism of complexity studies, that dealing with systems as complex and uncertain can leave decision makers unable to make any decisions about interventions. Choice paralysis is possible of course, and for this reason grassroots communitarians should focus on short feedback loops. Additionally, implementing interventions at the appropriate scale can help grassroots communitarians draw boundaries that are actionable instead of overwhelming.

3.9.2.2: Searching for Cures

While most grassroots communitarian frame adherents do not seek a single "magic bullet" to fix their problems, the belief that correct solutions, in other words, multiple cures, do exist. The modernist tradition can still be felt in this frame's search for cures. Grassroots communitarians are still focused on end outcomes rather than process-driven sustainability, and this can prevent them from fully participatory processes that can better inform and adapt sociotechnological solid waste management systems.

An example of this from the historical research is the "waste hierarchy" view of zero-waste advocates. An adapted version of the waste hierarchy is given in Figure 2. While there is a clear preference for practices such as reduction and reuse, recycling and composting are also complementary solutions. Rather than focusing all their efforts on a single strategy, educating others about the relative importance and impact of each step of the pyramid is the goal.

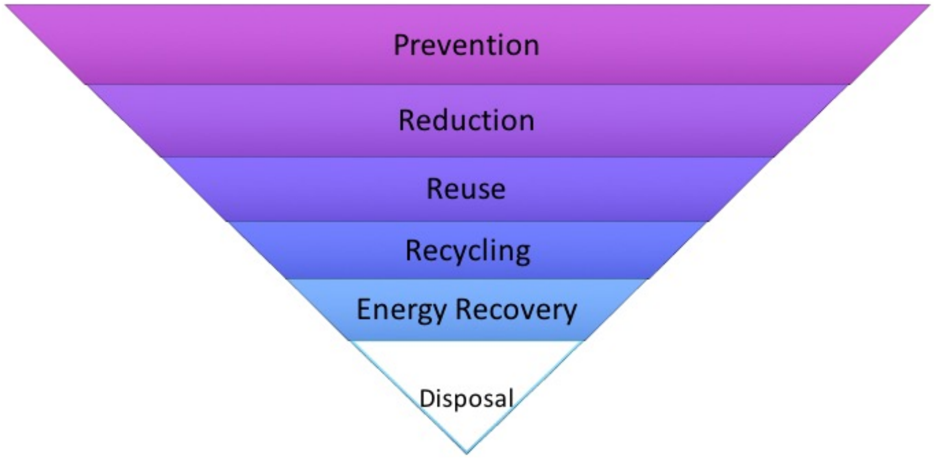


Figure 2: Waste Hierarchy

(source: author)

3.9.2.3: Coalition Building as the Answer

Grassroots communitarians place less absolute faith in the idea that technology will solve their problems than rational positivist planners do. Instead, grassroots communitarians are devotees of coalition building between other groups. "Professional white elites, from sanitary engineers to settlement house workers, rarely sought to organize a grassroots multiracial 'urban environmental health' social movement or merge their work with concurrent movements for occupational health and safety and environmental conservation" (Corburn 2009, 37). While professional white elite engineers, who mainly were rational positivist planners, kept to themselves, settlement house workers did create coalitions both between other settlement houses across cities/states and between themselves and other civic reform organizations.

While coalition building can bring in more types of knowledge and priorities, it can also fall into the trap of watering down those same priorities; this critique has been levied against “green” culture. Some critics argue that the popularization of sustainability has left the movement “empty” and can therefore “disallow real education to happen” (Adams 2011, 725). The specific concerns of sub-movements can be subsumed into a larger message, causing the message to become both more palatable but at the same time oversimplified (Rogers 2010). In the case of early civic reform organizations, this was often the case; groups that began attempting to address sanitation were folded into overarching civic groups and lost their waste message along the way.

3.9.2.4: Generalizability of Methods

Since the grassroots communitarian frame places a higher value on social networks, leadership, and knowledge than it does on technological fixes, it is natural that their methods of both research and interventions would also be more qualitative in nature. Qualitative research and knowledge creation can reveal specifics in certain cases that are generalizable to different contexts, aiding research across systems and communities. Grassroots communitarians are likely to try out "best practices" from other cities and neighborhoods, which is related to their reliance on coalitions and networks of citizen knowledge.

Evidence of this characteristic of the grassroots communitarian frame can be seen in manuals and how-to guides proliferated by both government agencies and civic organizations. The EPA has created guides on everything from solid waste management decision making in general to land reclamation specifically. The League Women Voters' recycling, nuclear waste, and plastics "primers" are another example of such best practice dissemination. While sharing knowledge across systems can be beneficial, grassroots communitarians must be careful to pay attention to their own specific context in order to avoid the trap of universality.

3.9.2.5: Communities Aiding Experts to Make Decisions

Grassroots communitarians look to citizen science and knowledge creation to inform decisions, and thus they also look to methods of participatory planning and decision making in solid waste management. Settlement house workers relied heavily on surveying their own neighborhoods and bringing this information to sanitation planners to inform expert-made decisions. Environmental justice activists have "also asserted a central role for community perspectives and expertise, grassroots leadership, and collaborative sciences that have helped redefine environmental health" (Corburn 2009, 126).

A modern analogy to this characteristic of the grassroots communitarian frame is a process like participatory budgeting, “in which ordinary city residents directly take part in allocating portions of municipal budgets through a democratic decision-making process” (Harvey 2012, xii). Similar citizen-informed priority setting for solid waste management has not always faired so well, especially when NIMBYism has prevented the siting of landfills in many U.S. communities. Therefore, a reformulation of such processes may be necessary in order to reframe waste as a resource moving forward.

3.9.2.6: Advantages of the Grassroots Communitarian Frame

One advantage of a grassroots communitarian frame is its insistence on localized knowledge and intervention techniques. Such context-specificity will be useful in reframing waste, since history has shown that one-size-fits-all solutions have not effectively addressed solid waste issues so far. Another advantage that grassroots communitarian framing allows for is effective mobilization of citizens around broad environmental issues. Finally, by connecting the socio and technical portions of solid waste management systems, grassroots communitarian framing presents an opportunity to connect these two historically disconnected components.

3.9.3: THE INSURGENT RADICAL FRAME

Although less explicitly dealt with in many planning histories, insurgent planning also has a long history in the U.S. As discussed in the last section's critique of Melosi, *insurgent* refers to planning done by ordinary people "either excluded from or in resistance to state-directed, modernist planning" (Sandercock 1998, 21) that seeks to create and support "new and other sources of meaning" (Holston 1998, 39). *Radical* refers to an ontology that seeks to dramatically alter the material conditions of the individual's reality.[15] Together, I hope to instill in the *insurgent radical* frame a notion of upsetting balance and status quo from the margins inward. I want to draw attention to both the group and/or spatial dynamics with *insurgent* and the frame's view of reality with *radical*. Insurgent radical planning is exemplified by the following characteristics:

1. Problems are completely intertwined with one another and cannot be separated.
2. Rather than looking for the "right" solution, we should try everything that has positive impacts.
3. Solidarity and social justice will be the answer to our problems.
4. What works for one city might not work for another city.
5. Citizens have a responsibility to address urban problems, and therefore community members are the experts who should make decisions.

[15] Interesting to consider, in light of the multitude of metaphors that liken urban growth to cancer and planners "treating" urban diseases, is one of Merriam Webster's definitions for "radical." Definition 1d: "designed to remove the root of a disease or all diseased and potentially diseased tissue" (*Merriam-Webster's Collegiate Dictionary*, 11th ed., s.v. "radical").

3.9.3.1: Problems as Inseparable

Insurgent radical framing views problems as fully interrelated and believe that all symptoms must be addressed holistically in order for reality to improve. This view is similar to the view grassroots communitarians take when defining problems. As Rittel and Webber (1973) argue, "every wicked problem can be considered to be a symptom of another problem" and therefore systems of intervention must be set up with this in mind (165).

An historical example of the insurgent radical frame's belief that many orders/levels of problems are inseparably linked comes from the Young Lords. These insurgent radicals believed that issues like El Barrio's infrequent waste collection could not be separated from their larger agenda that included issues ranging from "police brutality, drug addiction, education, the war in Vietnam, and independence for Puerto Rico" (Whalen 2006, 816). Problems that a rational positivist would consider separately as either local, national, international, or global, an insurgent radical planner would characterize as facets of the same issue.

3.9.3.2: Focus on Improving Rather than Solving

The focus of the insurgent radical is less on solving a problem, and more on finding ways to improve the concrete realities of their community. An insurgent radical frame is suspicious of authorities that claim to have "the answer," based in historical disadvantageous outcomes. When city sanitary officials ignored the waste collection needs of their neighborhoods, settlement house workers organized to clean their own streets of refuse. They were not looking for a solution, but focused on the process of making demonstrable improvements. Many times, since insurgent radical planning occurs on the fringes of society, immediately pressing concerns trump the search for a long-term solution within a system.

This aspect of insurgent radical framing is closely aligned with scholars who argue that sustainable systems ought to be process-focused rather than outcome-focused. Approaching interventions in this way allows for constant feedback and adaptation, something that insurgent radical planners believe is necessary to arrive at just and desirable improvements.

3.9.3.3: Solidarity and Collective Resistance as the Answer

Insurgent radical framing places a high value on solidarity and collective resistance. Whereas grassroots communitarian planners are devoted to coalition building, insurgent radical planners are more unyielding in their ideologies and convictions. Instead of tempering their views to build a wide base of support with other environmental interests, insurgent radicals will advocate for their specific cause to the extremes. The purpose of these direct actions is to “generate tension, to expose myths and assumption of the dominant mindset, to create a situation in which corporations, developers and government agents are willing to negotiate" (Devall 1991, 248).

Groups like Greenpeace have often engaged in nonviolent direct action in order to practice collective resistance to solid waste management. See Figure 3 for one example of resistance and protest actions by insurgent radicals; the banner that Greenpeace activists hung from the *Mobro 4000* barge in 1979 read "Next Time...Try Recycling." In the case of the insurgent radical planners of Greenpeace view engaging in direct actions, monkeywrenching, and ecotage not as "vandalism or random attacks on technology," but as "directed, targeted, and ethical action in defense of living systems" (Deval 1991, 251).

However, many critics feel as though these types of direct action are "guerilla" destruction of property and injurious to "the innocent" (Bandow 1991, 260). Insurgent radical framing can alienate other potential allies to its cause, which must be accounted for in the work to reframe solid waste as a resource.

Figure 3: Greenpeace Activist Banner Hung on the *Mobro 4000*

(source: New York Daily News Archive 1979 via Getty Images)

3.9.3.4: Context-Specificity of Methods

Similar to grassroots communitarians, insurgent radicals are leery of answers that do not pay attention to local context. Perhaps more so than grassroots communitarians, however, the insurgent radical planner's marginalization compounds this view and leads to methods of knowledge creation and decision making that is even more context specific. Methods of intervention are often linked to protest actions for insurgent radical planners, and such actions are inherently context-dependent.

3.9.3.5: Citizens as Decision Makers

For the insurgent radical frame, decisions should be made in complete transparency and within a fully democratic consensus-building process without impediment from state authorities. When authorities are silent or oppositional to the will of insurgent radicals, it is possible that protest and even violence can erupt, as has been the case across environmental justice movements from minority groups in the United States.

Unfortunately, because state authorities tend to control the messaging of incidents through media and official channels, the protests of grassroots communitarians are often contrasted to "riots" held by insurgent radicals. This, of course, is an unjust characterization of all protestors, but groups such as the Young Lords have been referred to as turf gangs when they resulted to violence that they believed to be justified, while (mostly white) civic reformers have been praised for sticking to their values in our history books. Due to this double standard, the insurgent radical frame has to work against being discounted and may need to adopt a pacifistic ideology to be incorporated into a reframing of solid waste.

3.9.3.6: Advantages of the Insurgent Radical Frame

Insurgent radical frames offer views from the fringes of sociotechnological systems that can throw into relief failures that may not be recognizable to rational positivists and grassroots communitarians, a major benefit. By being both imbedded in and at a distance from current solid waste management decision making power, amplifying insurgent radical planners lets us “make the invisible visible,” and as Sandercock (1998) notes, “uncover new meanings in old practices and suggest new methodologies and new themes” (21).

Finally, the insurgent radical frame is firm in its pursuit of justice, and this is certainly an advantage in reframing waste as a resource. Addressing the inequalities that landfilling and other solid waste disposal technologies have both created and been used to reinforce with a clear set of values will offer guidance to planners when they face inevitable opposition or setbacks. As long as the frame adopted in the next era of solid waste management can remain both steadfast and adaptive, there is a good chance that planners will be better off intervening and creating positive improvements than they have been historically.

3.10: Summary of Municipal Solid Waste Planning Themes

This section will synthesize findings from my historical research on topics other than MSW management framing. In addition to my analysis on MSW framing and its impacts, I am able to articulate several additional findings that will inform my frame development in chapter four and case study analysis in chapter 5.

3.10.1: Urban Dynamism and the Wayward Search for a Panacea

Seeking one technological cure-all for MSW management has not solved the metabolic rift in dynamic and complex cities. Lanham, et al. (2016) argue

> "By striving to better understand systems in which sustainability is sought, one can begin to uncover fundamental system characteristics, identify previously unrecognized patterns in relationships, and discover new insights into solving the challenges it presents" (52).

While Rittel and Webber (1973) characterize such complexities as "wicked problems," Lanham, et al. choose to view *complex adaptive systems* as constantly fluctuating and to plan with the certainty of uncertainty in mind. Even when planners find a solution to a symptom of the metabolic rift, it is unlikely that it will be able to satisfy rapidly changing conditions in the long-term, since external stimuli and disturbances are a sure thing given enough time. Attempting to suppress any disturbance by accepting the status quo of technology can result in system sub-optimization and is not truly aiming at resilience (Krook and Baas 2013). Rather than preventing disturbance, planners of solid waste systems should appreciate that "disturbances...have the potential to create opportunities for doing entirely new things" (Krook and Baas 2013, 2).

3.10.2: Technological Change as Incrementally Slow Boundary Expansion

Technological change, at least in regard to solid waste management in the United States, has been slow and incremental up to this point. We have tweaked and revised the same few technological options for waste disposal for nearly a hundred years, though this is not to say technology has not changed at all. Landfills, once little more than open pits, have advanced groundwater monitoring systems and highly regulated operations and procedures. From incinerators, we have developed newer cleaner burning waste-to-energy facilities. However, the basic core of the system has not changed. Waste is still dealt with linearly rather than cyclically in the majority of cases, with technologies like recycling and remanufacturing still far from mature sub-industries.

Each time that technology advances, along with the advance comes an expansion of the system boundaries of solid waste management. New materials and types of products such as plastics and single-use consumer packaging have stressed these system boundaries, exposing tension between managers of sub-systems within solid waste. So far, each expansion has been justified in economic terms, whether it means additional jobs and revenue for companies (in the case of recycling), or fewer dollars spent on dealing with hazards for governmental agencies (in the case of heightened landfill and incinerator regulations). However, a holistic frame of waste as not only a nuisance, a hazard, or a profit stream has not yet fully emerged. It is likely that we are on the brink of a paradigm shift, or reframing, as Kuhn (1970) argues large “scientific revolutions” occur relatively rapidly following slow incremental build up.

3.10.3: Context-Dependency of Successful Sociotechnological Systems

History shows that solutions developed for one system in one context seldom have a one-to-one correspondence when applied to new systems. Context-dependent systems are more successful in nature; species with niches tend to thrive within those niches. However, transplanting that same thriving species to a new context will almost certainly produce a sub-optimal result, both for the specific species and for the ecosystem it is introduced into.

Solid waste management as a field has largely ignored the need for context-specific solutions. With rational positivists at the helm for most of MSW management's history in the United States, solutions have been universally applied and have met unexpected inefficiencies as was the case with European-style incinerators. Physical factors like geography, soil, and climate can affect the success of technological systems like sanitary landfill liners and caps. Social customs can affect the success of technological systems as shown in the example of reduction plants. As complexity theorists argue, the best way to deal with these context-specificities is continuous sociotechnological analysis, rather than relying on intermittent stop-gap solutions (Lanham, et al. 2016).

3.10.4: Professionalization as Orthogonal to Public Interest

The professionalization of knowledge and expertise into concentrations of authority contributes to both technological momentum and system lock-in (Hughes

1994; Unruh 2000). Numerous critiques from both capitalists and anti-capitalists on the dangers of licensure, including that professionalization leads to suppression of competition that can spur innovation and creates a privileged class, little better than a cartel (Smith 1776), or that the state-sanctioned authority of such a class is counter to the general citizenry's interest and would force lower classes into a dependent position (Marx 1867). These views have been more recently articulated by Saks (1983) through a neo-Weberian approach that focuses on "closure" as a means of "restricting access specific opportunities to a limited group of individuals" (5-6). In examples such as health care (Saks 1995) and architecture (S. Moore 2017), it can be seen that professionalization is not necessarily in the public interest, although altruistic professional ethics codes typically reference the need to address social inequality.

In the case of solid waste management, the maturation and professionalization of the field in a rational positivist frame has created "closure" for grassroots communitarians and insurgent radicals. Further, inequalities within the field have impacted which professionals are viewed with more authority (Saks 2015). This is solidified by normative historical perceptions that MSW is the purview of engineers more so than of planners, have led to a dual "letting-go" of solid waste by planners and a "wresting away" by engineers. Finally, as Moore (2017) succinctly argues in regard to the relationship between professionalization and education,

> "the pressures of production influence what gets taught, just as what gets taught influences production. Both education and production are mediated by licensure—the standardization and certification of knowledge" (50).

The impact of licensure on planning and engineering has not always had a positive impact on the public interest, as clearly demonstrated when insurgent radicals push back against these injustices.

3.10.5: Frame Shifts and Their Causes

Similar to the development of technological change over time, the structure of scientific revolutions is incremental as well at first. That is, until there is a sudden bust forward into a new dominant frame, or as Kuhn (1970) describes it, new paradigms ("incommensurable ways of seeing the world and of practicing science in it") (4). The bursts forward are the "tradition-shattering complements to the tradition-bound activity" of "normal" planning that occur when "the profession can no longer evade anomalies that subvert the existing tradition of...practice" (Kuhn 1970, 6).

Examples of such frame shifts can be seen in the history of solid waste planning in the United States. Early waste frames characterized it as little more than a *nuisance* until a scientific revolution, the introduction of germ theory, occurred in public health that forced planners to reconsider and reframe. This frame dominated in the early to mid-twentieth century until growing recognition of anomalies in the environment led to another revolution, this time framing waste as a *hazard*. Today, a combination of technological advancement, external system pressures, and spreading neoliberalism have set the stage for a new reframing, with waste as *resource*. It is critical to notice that each of these reframings of waste occurred alongside increased participation in the planning process from grassroots communitarians and insurgent radicals. Recognizing and taking advantage of changing tides now will enable planners to take advantage of the exciting opportunity to guide the next iteration of waste characterization away from a "disappearance paradigm" and into a circular flow.

3.10.6: The Nature of Neoliberalism

Neoliberal economics characterize MSW as a personal consumption choice rather than a systemic issue that can be addressed through policy and regulation. The structure of neoliberal economies tends to support spatial and temporal inequalities, which can be thought of as one system attempting to externalize its negative effects outside its system boundaries (Harvey 1996).[16] As Harvey (1996) notes, neoliberalism as anything other than an aid for a select few to accumulate capital is a "myth;" instead, real wealth creation "depends on a mix of social

[16] See section 3.7 of this project for a more in-depth examination of how this works.

collaboration and cooperation...on adaptations and on the shaping of the environment" that can only be realized in "the pursuit of social justice" (436-437). Frame shifts involve shifts in power fraught with both economic and political conflict, as evidenced by the shifts between private and public management regime changes in sanitation infrastructure. These power imbalances and realignments must be central to a new planning frame for sociotechnological systems such as solid waste management.

Neoliberal economies also place the onus and blame for problems on the individual, in the false name of "freedom" to choose that accompanies the deregulation of industries that could be instead held accountable for their actions. In solid waste management, this aspect of neoliberalism has shown up in the push for individuals to "do their part" to conserve by jumping on board with single-stream recycling. We have also seen critiques of neoliberal ideology from insurgent radical planners in cases of community response to hazardous waste and other health and safety risks posed by landfills and incinerators. Finally, whereas a majority of waste is generated during production phases in extractive sectors like mining and industrial agriculture, neoliberalism's mantra of individualism has placed the focus of environmental efforts to address solid waste management at the end of the production-consumption cycle. And worse still, is the neoliberal insinuation of individual guilt and shame for those who forget to recycle their junk mail, the result of popularized green norms and values. Systemic and widespread problems like waste generation during production and manufacturing are better suited to being addressed by legislation and regulation than trusting that capitalists in power will choose to do the right thing on their own.

3.10.7: The Need for Triage and Treatment of Underlying Conditions

Returning once more to the public health paradigm from which solid waste management began at the end of the nineteenth century may help untangle the complexities of the garbage "crisis." The public health paradigm framed disease as a collective or systemic issue, rather than as a personal issue detached from one's environment. Solid waste has repeatedly been referred to as a disease or cancer on society (Small 1970, 7). However, the way in which we treat this health problem of our society is not cognizant of the importance of triage techniques. Without more systemic information, the portions of the garbage problem that are chronic and acute are difficult to untangle. Chronic issues include:

> "the unwieldy volume of waste, inherent problems associated with collection, the impulse to depend on a single disposal option rather than a clear disposal strategy, emphasis on 'back end' solutions to what may be 'front end' problems, the debate over public versus private operation and management, and jurisdictional disputes over regulation" (Melosi 2000, 421).

These issues have played a part in waste management issues since the first push to tackle sanitary reform over a hundred and fifty years ago. None of them can be completely "cured" with newer, more efficient, cleaner, or cheaper technology.

With sanitary, nowadays termed *environmental* engineers at the helm, these chronic and complex sociopolitical question of public priorities cannot effectively be addressed.

Engineers as a profession are more likely to be key in solving the "acute" problems of solid waste, such as:

> "increasing amounts of toxic materials in the municipal waste stream, the squandering of limited resources, lack of viable landfill space, and increased levels of air and water pollution" (Melosi 2000, 421-422).

While the "crisis" issues of acute disease symptoms shoved solid waste to center stage in the era of environmental activism, the solutions proposed and implemented (recycling, waste-to-energy technologies, scrubbers, liners, etc.) have not meaningfully addressed the underlying chronic issues. A classic "wicked problem," as characterized by Rittel and Webber (1973), solid waste management must be understood in its richness and complexity and how it interacts with other wicked problems to attempt solutions that will create positive effects. Both of the major leaps forward in how we handle garbage thus far in the United States, as evidenced in this chapter, have involved community action to spur popular attention, but we have subsequently attempted to "solve" the sociotechnological problems through purely technological means. In the next chapter, I will explore an avenue forward that can help address both the chronic and the acute problems of waste management by marrying the technological and social dimensions into truly comprehensive solutions.

CHAPTER 4: GEDDES' THEORY OF BIOTECHNICS: A OLD FRAME TO CONFRONT CONTEMPORARY PROBLEMS

Looking back at the last hundred and fifty years of organized waste management in the United States, it is obvious that we have made great strides. Horse manure no longer covers our busiest streets, we have extensive (if crumbling) water and sewage conveyance systems and no longer face the full intensity of myriad diseases that devastated urban populations at the time.[17] However, solid waste management has fared less well than its cousins water, sewage, and street cleaning in its conquering, though all of these are subsystems of a larger urban metabolism in our cities.

Solid waste collection currently has an inherent requirement for human labor that cannot be ignored, whereas the majority of most sewage, water supply, and street cleaning operations have been either mechanized, automatized, or hidden in underground infrastructure networks. Although in both early sanitary reform and later landfill regulation tightening/recycling encouragement large technical strides were made in our understanding and methods for waste collection

---

[17] There is reason to believe that a portion of our waste problems have not been effectively dealt with, that they have rather been moved from solid to gaseous in the form of particulate matter.

and disposal, the frame of waste as inevitable has not yet been surmounted. It seems that if our waste problem, then, is to be effectively managed, we may need a broader approach to the types of solutions we try, one that marries technological innovations with social and procedural innovations as well. Geddes' theory of technics and civics skillfully and usefully combines both socio and technical processes into a holistic approach that may just provide the frame that can lead the way forward.

What follows in this chapter is a brief overview of Patrick Geddes' background, contributions to planning, and influence on the field today. I will outline the portion of Patrick Geddes' theory that deals with paleo-, neo-, geo- and biotechnics and the analogs in municipal solid waste management, and then in the next section explain the importance of civics that support and informs, and at times drives, technics. Finally, I will provide an argument for the use of civics as a way to alter the "waste" frame, and elucidate the connection between what already exists in practice (zero-waste and resource recovery), and a civics-oriented goal beginning to emerge: a circular economy.

4.1: Sir Patrick Geddes: A Turn of the Twentieth Century "Renaissance Man"

As his best known protégé, Lewis Mumford wrote in the acknowledgements of his book, *The Culture of Cities* (1938):

> "my chief intellectual debt is to my master, Patrick Geddes...on the subject of cities there were few areas where Geddes was not master: he was not merely a profound sociological observer but a practicing townplanner. There were not many departments that Geddes did not at one time or another cover; little that he did not, if only by a passing flicker of epigram, illustrate..." (495).

Born in Scotland in October 1854, Geddes grew up outside of Perth (Meller 1993, 5). He was raised as virtually an only child, the youngest of five children and Geddes' father instilled in him at an early age curiosity and a love of the countryside (Ziffren 1972). As a young man, Geddes enrolled at the University of Edinburgh to pursue botany, but found higher education proscriptive and too narrowly focused; he had, after all been free to teach himself anything he wanted previously and "could not limit his focus" (Ziffren 1972, 5). He left after a week, inspired to take courses with Thomas Huxley (Kitchen 1975). He would go on to study zoology, marine biology, history, and many other natural and social sciences, "virtually [invent] the scientific study of Town Planning" and "[inspire] the founding of the British Sociological Society" (Law 2005, 1-2). However, he never completed any degree and was summarily rejected from every academic post he sought, only receiving a Chair in Botany at Dundee College paid for by his wealthy benefactor, James Martin White (Law 2005, 1-2). His piecemeal academic employment was complemented by his professional practice; Geddes created plans for a number of towns in his native Scotland as well as celebrated plans for Madras and Indore in India, Jerusalem, and Tel Aviv (Hysler-Rubin 2011).

Geddes was both a product of his time and an outlier among his contemporaries. He sought a totality, a view of the world as it is and its future, and his prime impetus was to "transform the nineteenth century ideal of progress: 'from an individual Race for Wealth into a Social Crusade of Culture'" (Meller 1993, 3, quoting Geddes 1886). Patrick Geddes, living through the great leap of Industrialization, was familiar with the abysmal conditions of the urban centers. Recently, the environmental movement has found ties back to his writings, and he is "regarded as a precursor of our own growing environmental awareness;" and the origin of the phrase "think global, act local" (Hysler-Rubin 2011, 27). His theory of planning can be seen in growing movements within the field now such as participatory planning and bioregionalism. Geddes' valuing of small-scale 'conservative surgery' interventions and public participation is "at the very core" of his planning (Hysler-Rubin 2011, 26). His civic surveys, Outlook Tower, and Valley Section tools are highly applicable for studying society at a regional scale (Hysler-Rubin 2011, 26-27).

While ties to Geddes can be found almost everywhere in contemporary planning practice, they have to this point come to widespread use almost entirely via other planners, and the Scotsman's eccentricities and "disregard for politics" have led to three general feelings on Geddes (Hysler-Rubin 2011, 38-39). He commands a small but fiercely loyal band of devotees, who see him as a genius ahead of his time; he attracts a similarly-sized or perhaps even smaller group of critics who argue that his methods were not of his own invention and that his practice represents many of the nefarious aspects of colonialism and the search for totalities; and, finally, he remains practically unheard of to the vast majority of those in the many fields he was influential in (Hysler-Rubin 2011, 36-39).

4.2: Geddesian Technics: Definitions and Examples

While much has been debated over the way in which we should structure our society before, during, and since Geddes' lifetime (i.e., capitalist vs. socialist, individual vs. state, etc.), Geddes saw the tension of our modern world as a battle "between the Paleotechnic and Neotechnic order" (Geddes 1915, 82). Adapting the concept of the *Paleolithic* and *Neolithic* early humans in the Stone Age, Geddes termed the primary portions of the Industrial Age as *Paleotechnic* and *Neotechnic* (Geddes 1912, 177-178; Geddes 1915, 62-64). Accompanying every kind of "technics," or "culture of production encompassing the technologies, materials, and energy sources," is a corresponding "civics," or an "inseparable social organization of a given ecology of production" (Young 2017, 29). This section explores the distinction between the types of technics and provides examples of each, while the following section will explain the importance of fusing technics with civics.

4.2.1: PALEOTECHNICS

In the heyday of the Industrial Revolution, Geddes looked at the rapidly industrializing cities around him and saw a

> "sorry aggregate of ill constructed houses, mean or showy without, unhealthy within, and containing little of permanent value...dirt and darkness, smoke and sewage everywhere, as if its inhabitants had absolutely *framed* the ideal of a short life and a dismal one, with which they are dull enough to rest contented" (Geddes 1900, 304; emphasis my own).

His background as an evolutionary biologist and interdisciplinary thinker made him seek a way to understand the changes in the world around him. The wasteful, unsanitary, and inhumane lives of city dwellers brought him to characterize the "primitive" industrialization that had both technological and social dimensions: paleotechnics. Paleotechnics, the earlier, less refined stage of industrial activity, is characterized by Geddes as "comparatively cruder and wasteful," a period in which humans are embroiled in "trade competition, Nature competition, and war competition, in threefold unity" (Geddes 1905, 107; Geddes 1915, 77). In more explicit terms:

> "paleotects...make it [their] prime endeavour to dig up coals, to run machinery, to produce cheap cotton, to clothe cheap people, to get up more coals, to run more machinery, and so on; and all this essentially towards 'extending markets'" (Geddes 1915, 74).

Industrialists in search of profit at the expense of all else are the consummate paleotects, with their disregard for the natural and human resources consumed in pursuit of “money-wealth” (Geddes 1915, 72-73).

This vicious, self-perpetuating system of production puts people in competition with nature and in competition with each other without creating true wealth as an economy should; in fact, Geddes calls paleotechnic systems of production “not economics, but Waste” (Geddes 1915, 67). More than specific technologies or processes of production and consumption, a paleotechnic view of the world is reminiscent of Heidegger’s “standing reserve” (Heidegger 1977). The metaphor of the “standing-reserve,” similarly to paleotechnic modes of production, emphasizes an object’s ability to be ordered and categorized, and the ease of substitutions between objects that are always waiting at the ready for the use of humankind (Heidegger 1977).[18]

Paleotechnics is wasteful in nature, and fulfills its “threefold unity” of competitions by perpetuating war through the imperialism necessary to continuously replenish a “standing-reserve” with more and more resources from

[18] While humankind uses and abuses the standing-reserve, we are also merely the “orderer” of the standing-reserve: “man...is nothing but the orderer of the standing-reserve, then...he comes to the point where he himself will have to be taken as standing-reserve. Meanwhile man, precisely as the one so threatened, exalts himself to the posture of lord of the earth” (Heidegger 1977, 27).

farther and farther away (Geddes and Slater 1917). The result is a small number of "War Capitals," the "new Romes" represented by Paris, Berlin, London, and New York, which experience the "dual yet unitary process of outward centralization and inward decay" (Geddes and Slater 1917, 230). Notably, these "war capitals" may be either primarily financial or political in nature, but either way they perpetuate a state of continual "wardom," "whose peace is mere war-peace," a temporary peace between wars (Geddes and Slater 1917, 234).

Much of the early history of solid waste management is characterized by paleotechnics. The open dumping of waste in water and on land is emblematic of a disregard for all else but profit. That it continued in many municipalities after the dangers of insect and rodent infestation and pollution became widely known is testament to that. Rather than finding a way to deal with the waste, the easiest and cheapest option was employed to simply move the problem elsewhere instead of addressing it head-on, as neoliberal economies often attempt and succeed at exporting burdens to weaker systems (Harvey 2006). Many parts of the world still condone this practice, especially in less developed countries, and the World Bank (2016) estimates that unregulated or illegal dumpsites on land "serve about 4 billion people and hold about 40% of the world's waste." Open dumping is still an issue today in the United States, despite it being illegal nearly everywhere (regulation, especially without oversight or fear of punishment, is merely a neotechnic solution). The most typical wastes dumped are those that are more difficult to dispose of, like large appliances ("white goods"), construction and demolition waste, automobiles and automotive accessories, and tires (EPA 1998, 2-3). Even sanitary landfills, by far the most popular choice for most U.S. discards, have the potential for ground leaching and methane off-gassing and mismanagement examples are abundant. They are a temporary stop-gap for solid waste management, not a "disposal method," as is obvious to those who do not have a paleotechnic frame.

4.2.2: NEOTECHNICS

In contrast to paleotechnics, neotechnics is "directed by life towards life, and for life" (Geddes 1915, 71). The neotechnic order is "characterised by the wider command, yet greater economy of natural energies, ...and by the increasing victory of an ideal of qualitative progress, ...of social polity" (Geddes 1905, 107). The neotechnic city, then, is a "city of healthy and happy artists" creating a different kind of wealth, by "combining beauty with utility" (Geddes 1905, 107; Welter 2002, 17; Boardman 1944, 374). Geddes described the newer portion of the Industrial Age as "pay[ing]" in a different kind of way than the money-wealth and money-wages generated in paleotechnics (Geddes 1915, 75). Key to the purposes of this research project, neotechnics is also keenly concerned with "the utilization of waste" (Geddes 1917, 196). Neotechnicism can be fairly well equated with a conservation frame; Geddes himself notes that it involves us utilizing “more than ever each improvement and invention which can save energy, minimise friction, diminish waste or loss of time in transit,” and other forms of “parasitism” (Geddes 1912, 179). In an example, Geddes (1915) suggests that while the paleotect would be content with tearing down trees if it meant increased profits, the neotect would use:

> “his careful economisation of national resources, his care, for instance, to plant trees to replace those that are cut down, and if possible a few more, is occupied with real savings. His forest is a true Bank” (70).

Neotechnic solutions to solid waste management abound in our society today. One obvious example is incineration, which conserves the amount of land necessary for use as a landfill by reducing overall volume (Blumberg and Gottlieb 1989, 28). It may seem as though incineration plants play a greater role in “green” solid waste management, but at least in recent history the advocates for the industry “emphasized that its facilities were *best capable* of offering ‘a method of volume reduction’ of wastes, rather than generation of electricity” (Blumberg and Gottlieb 1989, 28; emphasis my own). The amount of value, or wealth gained from incineration operations is primarily due to this volume reduction, and sometimes even if energy is able to be efficiently and economically generated a buyer for it cannot be secured. Recycling programs also tend to be neotechnic in practice. Simply re-using a portion of the same material for a while to continue to produce things such a single-use beverage containers conserves resources, but does not place life above the profit motive.

4.2.3: GEOTECHNICS

Although less explicitly discussed by Geddes' writing, the next "stage" of the Industrial Age, *geotechnics*, is where the paradigm of production and consumption begins to really break with the old order. Geotechnics is the "remaking of the earth into an environment favorable to human life" (Boardman 1944, 374). More specifically to Geddes, geotechnics was a "science of making the earth more habitable and restoring its resources" (Kitchen 1975, 24). More than a conservation of energy, as in neotechnics, the restoration of resources and life moves the needle away from competition over money-wealth and closer to true wealth. Geddes saw geotechnics as the interdisciplinary field that he had also wanted to learn and teach, with the Outlook Tower and civic surveys as the primary teaching tools (Kitchen 1975, 142). The Outlook Tower and regional survey would provide students of geotechnics with a "synoptic vision" and as well as a "synthetic vision," so that "children and artists may see more than the wise" of their own landscapes (Geddes 1915, 321). Indeed, this type of local capacity building and citizen science are major tenets of a *grassroots communitarian* frame.

It follows that such a wide lens would lend itself to regional rather than global study, and indeed, Geddes inspired this type of regionalism in the generations of scholars after him. Benton MacKaye, in whom Geddes' ideas found a willing audience, began to work out Geddes' ideas of geotechnics in his book *The New Exploration* in an effort to restore regionalism in the United States (Boardman 1944, 411). MacKaye (1928) argues that the field of planning

> "thus found includes the three needs of cultured man which we have previously stated, namely, the conservation of natural resources, the control of commodity-flow, and the development of environment" (43).

One of the best geotechnic solutions that has emerged in the last century from an individual garden practice to a fully-fledged part of some municipalities waste management systems is composting. Composting has, excuse the pun, deep roots, including in pre-industrialized society in the United States but had fallen to the wayside as simply a home gardening technique until it began to gain consideration again in the late 1980s (Blumberg and Gottlieb 1989, 231-234). This technology begins to really generate wealth in the Geddesian sense, reusing traditionally wasted material for a higher-level purpose (rather than down-cycling which is more common in recycling schemes), regenerating the soil and sustaining localized economic development. One such early composting company, American Soil, Inc., had revenues of over $1 million in 1992, and was referred to by The Wall Street Journal as "the future" (Naik 1993). Today, many municipalities are attempting to integrate composting into their waste management systems, including Austin, TX (Austin Resource Recovery 2011).

4.2.4: Biotechnics

The final step, a new age, a break from paleo-, neo-, and geotechnics in the Industrial Age, is what Geddes called *biotechnics*. Biotechnics is defined by its "genuine, constructive and militant peace," a "Third Alternative" to "open war and latent war (called 'peace')" (Boardman 1944, 364). This frame is a new relationship between human and environment, between man and life itself, and it is the first phase fully distinct from the Industrial, or Mechanical Age (Young 2017). Where the Mechanical Age sacrificed life in the pursuit of profit, the new frame of biotechnics will prioritize life above all else. Indeed, Geddes felt that the Mechanical Age was missing the mark, and a fusion of biocivics and biotechnics would catapult the evolution of humans forward to a system that was

> "ultimately measured neither by its return in wealth of the capitalist nor in money wages of the labourer, nor even by both put together, but in the results of industry upon the concrete environment, the family budget, the home, and the corresponding state of development of the family—its deterioration or progress" (Geddes 1906, 79).

True wealth, beyond the money-wealth of paleotechnics, the conservation savings of neotechnics, and the "green" business of geotechnics, will involve this new life-centered way of production and consumption that Geddes envisioned.

Fully biotechnic and biocivic systems are ideals to strive towards, and therefore examples of this paradigm in solid waste management are rare; however, they are becoming more prevalent in wastewater management, a more developed sanitary infrastructure. In Austin, TX a wastewater treatment facility comes fairly close to this biotechnic ideal, named Hornsby Bend. The wastewater treatment facility run by Austin Water also houses the Center for Environmental Research at Hornsby Bend, the Hornsby Bend Biosolids Management Plant, and the Hornsby Bend Bird Observatory (Austin Water n.d.). The Biosolids Plant receives sewage solids from water treatment facilities in the city, and after treatment proceed to an anaerobic digester, afterwards being combined with yard waste from city residents and windrowed to create a high-quality compost fertilizer (Center for Environmental Research n.d.). The result of composting is packaged and sold commercially as Dillo Dirt, as well as used in land application for hay fields at the 1,200-acre site (Center for Environmental Research n.d.). Methane gasses are captured and stored throughout the process that generates enough electricity to power the digesters (Center for Environmental Research n.d.).

What pushes this project from geotechnics towards a biotechnic frame is the fact that all effluent is treated onsite in three ponds without discharging any water into surrounding waterbodies (Center for Environmental Research n.d.). The nutrient-rich effluent in these ponds attracts an impressive variety of wildlife to the facility, and Hornsby Bend is nationally renowned as one of the top birding sites in Texas and an ecotourism destination (Center for Environmental Research n.d.). All of this is in concert with research partnerships with both the University of Texas at Austin and Texas A&M University (Austin Water n.d.). The model at Hornsby Bend involves the unification of technical processes and civic processes, inviting students, birders, and hikers to enjoy, learn, and research alongside farmers, engineers, operators, and ecologists. Multiple revenue streams, and more importantly multiple regenerative value streams are created each year while at the same time actually improving the local ecosystem and engaging citizens in their region. Each component of Hornsby Bend is already in many ways innovative on its own, but the synergistic operation as a whole achieves admirably biotechnic results.

4.3: Geddesian Civics: An Ethical and Pragmatic Backbone

Geddes saw the requirement for a complementary social ontology to match the technical and material ontology of any frame in planning. As he put it in his unpublished work *Country and Town in Development, Deterioration, and Renewal*:

> "The central search of our age...is for a theory of Life in its Evolution, and this in all its aspects and products; and such a theory must deal, not only with the organic life therefore, but also with the psychic life; similarly with ethical life no less than with social...Futhermore, it must correlate the individual life with the social, and this in no mere abstract, ethical way, but as the citizen with his city" (Geddes c.1909-1910, quoted in Welter 2002, 50).

The idea of community was of pivotal importance around *fin de siècle* Europe and the United States, in much the same way that the idea of contracts was critical to the Age of Reason (Meller 1973, 298).

4.3.1: NOT ETHICS, NOR POLITICS, BUT CIVICS

However, Geddes' civics was more precise than "community" or "politics." Geddes hoped to progress from an obsession with abstract "Politics" to "sociology...effectively applied in the concrete" (Geddes and Branford 1917, 114). Geddes saw the politics of his time as only superfluously divided between the different candidates and parties (Geddes and Branford 1917, 116-117). What Geddes hoped for was deeper than the abstractions that politics afforded. Instead of speaking of the State and the Individual or the Society and its Members, Geddes believed that the appropriate frame of reference for true civics would be "Cities and their Citizens" (Geddes and Branford 1917, 121). He believed that politics concerned itself too much with debates over "the conception of 'Rights,'" and "increasingly, that of 'Duties'" (Geddes and Branford 1917, 117). With civics, Geddes states:

> "we neither discuss 'Rights " nor preach 'Duties;' but survey and examine concrete facts: and from this we come to feel, to see, and even, at times, to suggest, very definite Responsibilities" (Geddes and Branford 1917, 121).

Further, civics is not simply a new type of ethics or politics, but is also fused into the very system of production and consumption technics that a society practices. In a biotechnic society, economics would be ethical, and ethics would be economical, but not confined to the pecuniary terms we typically think of as economics today. Economics to Geddes is not fanatically seeking profit or growth, but instead well-being, stability, and creativity.

Geddes was often frustrated with “citizens for not being able to teach each other about civics,” but he understood that civics could never spontaneously appear without diligent work (Welter 2002, 78). People would need a deep understanding of their city and region to develop civics in the Geddesian sense, and using the tools of the regional survey and the Outlook Tower they would gain the knowledge about their home needed to do so (Welter 2002, 78). This work of building civics “unfolds through trial and error without guarantee of success” (Young 2017, 33) but training new citizens was vital to Geddes, and especially for those engaged in city planning (Geddes 1915, 298). “Organising activities” “for all social classes” would bring about this “civic regeneration,” and they would need to be concretely familiar with their region for those activities to take place (Meller 1973, 304). Planners, architects, and engineers that chose to simply address the symptoms of paleotechnics (dirty streets, poor health, low educational attainment, etc.), are ignoring the root cause of the problem, and reshaping technics is the way to treat such a chronic condition (Meller 1973, 310).

4.3.2: Examples of Civic Types in Municipal Solid Waste Management

Corresponding to paleotechnics, paleocivics are widespread in society today. Hierarchal, colonial, militaristic, and many forms of unregulated capitalism are all tied to paleotechnics (Young 2017). Policies and practices that protect free markets above everything else are paleocivic, such as areas where there are no regulations on burning trash or dumping waste into rivers and streams. Any kind of disregard for what happens to waste after it leaves your hands is part of a paleocivic system, such as “garbage imperialism” where “industrial nations...send their waste to disposal sites in ‘third-world’ countries” (Müller 2016, 17).

A neocivic approach to solid waste management would highlight conservation strategies, and focus on measures that individuals can take to reduce their footprint. Other neocivic policies include regulation such as the Resource Recovery and Conservation Act’s stricter controls on sanitary landfills, which do not ban landfilling but make it slightly safer.

Moving farther along the scale, geocivics in solid waste management is manifested in citizen participation and governance, as well as cooperative research enterprises. A prominent example of geocivic activity in Curitiba, Brazil provides low-income citizens who clean up waste with bus tokens for an impressive public transportation system (Rabinovitch and Leitman 1996). These reforms, however, have relied on military support of an elite technocracy, which though it “solve[s] real problems for clients” in transportation and other fields, “will not be able to adapt the systems...when the managers disappear” (S. Moore 2007, 217).

While it may seem discouraging or difficult to think of examples of regulations that espouse biocivic attitudes, look no further than the Endangered Species Act, which effectively bans harming the ecosystems of endangered species without any regard to profit or power. Another example of biocivic activity are pedestrian only zones that are being implemented in several U.S. cities, as walking is the cleanest form of transportation and the most life-enhancing. A biocivic example that comes from waste management would be regulations that ban single-use plastic and paper bags outright.

4.3.3: Overlapping Civic Frames and the Threat of Backsliding

Paleo-, neo-, geo-, and biotechnics, are not entirely separate and distinct in the world around us. As Boardman writes, they are "opposite yet mingling" and can overlap and coexist with one another (Boardman 1944, 374). Most importantly, the transition is non-linear, and neotechnics is "vulnerable to recolonization by the still dominant paleotechnic economy," providing the monetary savings from which paleotechnic "'remnants' can gain new strength and vitality" (Young 2017, 33). The only way to avoid this backsliding, according to Geddes, is to evolve a new form of civics to provide a spine to emerging technics. "*Plus ça change, plus c'est la même chose;"* the more things change, the more they stay the same. Geddes was fond of this saying, often including it in his writings (Geddes 1917, 234; Geddes and Branford 1917, 117, etc.). If robust civics are not integrated and synthesized into a new mode of production, a backsliding will occur and technics will be subsumed into paleotechnic approach.

An increase in resource efficiency is often coupled with an increase in the use of that resource, rather than the desired reduction; this phenomenon is known as the Jevons paradox (Lehmann and Crocker 2012, 5). This is reminiscent of the backsliding that Geddes theorized would occur if a technics or civics advanced without a matching civics or technics. The technological advance in resource recovery must be met with a new frame and policy structure for it to begin achieving a better outcome. As seen in the previous chapter, technological and engineering-driven solutions at the end of the nineteenth century and in the 1970s were not fully matched with a revolution in civics, though both were spurred by initial progressivism and environmentalism, respectively.

The way forward, as Geddes saw it, would be the "peaceful yet strenuous way of survival and evolution" (Geddes 1915, 83). Though seemingly utopian or unattainable, Geddes felt that biotechnics was still worth working towards; he wrote that "without these unattainable directions, these cardinal ideals, who could move from where he stands, save to sink down a hole?" (Geddes 1915, 87). Civics as Geddes realized it could provide the missing link to the attempted technics-focused solid waste management solutions that have failed to fundamentally change our production and consumption cycle and replace it with a new, non-waste frame.

4.4: Current Movements Tied to Geddes' Biotechnics

Currently, several emerging threads have begun to reframe waste into a resource rather than a discard to be ignored, including the zero-waste movement, urban metabolism studies, and circular economy studies. Each of these trends operates and considers a different scale (micro, meso, and macro) at which to start altering our waste-based frame. These trends, however, are not new and each has ties back to Patrick Geddes' theory of technics and civics. In the following sections, I summarize each of these three trends. The last section of the chapter synthesizes Geddes' imprints on the zero-waste movement, urban metabolism studies, and circular economy studies and calls for a biotechnic frame to unify the threads going forward.

4.4.1: The Micro-Scale: The Zero-Waste Movement

A different frame has begun to emerge in a real way recently, though a push for societies to become "zero-waste." Zero-waste definitions can vary, but the Zero Waste International Alliance adopted the following definition in 2004 (revised in 2009):

> "Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.
>
> Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials,

> conserve and recover all resources, and not burn or bury them.
>
> Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health" (Zero Waste International Alliance 2009).

While some definitions of zero waste quite literally highlight the total elimination of waste from processes of production and consumption, others recognize that it may be impossible to completely achieve this goal, such as the City of Austin's target to reduce waste sent to landfills and incinerators by 90% by 2040 (Austin Resource Recovery 2011, 6). The zero-waste paradigm seeks to reframe waste as a previously mishandled resource rather than a burden to be hidden. "Waste was once seen as a burden" but "shifting attitudes...have led to the identification of waste as a valuable resource" (Lehmann 2012, 310).

The zero-waste movement has as its primary targets individual community members. It operates at a micro-scale, suggesting changes that individuals can make in their daily lives in much the same way that conservation strategies were marketed to individuals at the end of the twentieth and beginning of the twenty-first centuries.

4.4.2: The Meso-Scale: Urban Metabolism Research

Kennedy, et al. (2007) define urban metabolism as "the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste" (44). The field (and term) has its roots in Karl Marx's *Capital* (1894), where he writes of the "conditions, which cause an incurable break in the interconnectedness of the social circulation of matter prescribed by the natural laws of life" (945). This idea, which has also been translated by other editors into English as a "metabolic rift," has spawned a recent interest in urban metabolism studies (Foster 1999). Urban metabolism studies have primarily fallen into two divergent categories: (1) energy equivalence studies and (2) mass flux studies (Kennedy, et al. 2011). The first category, energy equivalence studies, follow the work of Odom (1983) and are sometimes referred to as *emergy* studies, the unit of measurement he devised to calculate solar energy equivalents for other types of fuel. The second category, mass flux studies, reports mass fluxes in the more accessible unit, joules (Kennedy, et al. 2011). A large body of work has emerged analyzing everything from spatial aspects of metabolism to specific nitrogen and phosphorous levels, but both emergy and mass flux studies still have difficulty measuring social factors in the metabolism of a city (Kennedy, et al. 2011). As the tradition has been primarily based on case studies and easily quantifiable flows, the social factors influencing a city's metabolism are still in need of work (Kennedy, et al. 2011).

What we need to address solid waste head-on is a "closed-loop" process. Although waste is highly visible as municipal solid waste at the end of the material cycle, waste generated during the extraction, processing, manufacturing, and distribution phases "can be many times the volume of waste eventually materialized" at the landfill (Walker 2012, 151). Different products consume more or less resources in different stages of their creation and use, but the tools of life-cycle analysis (LCA) can be employed to better understand the consequences of design decisions (Walker 2012, 151). Whether from a life cycle analysis or urban metabolism study perspective, or an ecological design perspective, the consensus around the need for a new way of interacting with the environment is clear; as McDonough and Braungart's *Cradle to Cradle* (2002) succinctly argues:

> "Waste is nutrients. Waste is precious. We should learn from Nature; Nature doesn't know 'waste.' In Nature, one species' waste is another species' resource" (quoted in Lehmann 2012, 324).

4.4.3: The Macro-Scale: A Circular Economy

Another contemporary frame challenges the concept that waste is "inevitable or unavoidable," and shifts attention towards building a circular economy (Levitzke 2012, xxiii-xxiv). A circular economy "aims to leave the dominant linear economic model" in favor of "a circular economic model that acknowledges a more environmentally sound bio-based and renewable resource use" (Johansson 2016, 2). In much the same way that Chadwick conceived of the ideal sewage management as "bringing as it were the serpent's tail into the serpent's mouth," a circular economy would utilize all outputs as inputs (quoted in Finer 1952).

The following definition from Pining, et al. (2013) explains the concept in greater detail:

> "The circular economy is a generic term for an industrial economy that is, by design or intention, restorative, and in which material flows are of two types: biological nutrients (which are designed to re-enter the biosphere safely) and technical nutrients (which are designed to circulate at high quality without entering the biosphere). The term encompasses more than the production and consumption of goods and services, including a shift from fossil fuels to the use of renewable energy and the role of diversity as a characteristic of resilient and productive systems" (Pinjing, et al. 2013, 147).

The historically linear waste process in U.S. cities has been summarized and compared to what a cyclical economy would look like in Figure 4. The circular economy is an outgrowth of the study of urban metabolism, an accounting of inputs and outputs of a city and the balance that is or is not achieved by current systems and processes (Wolman 1965).

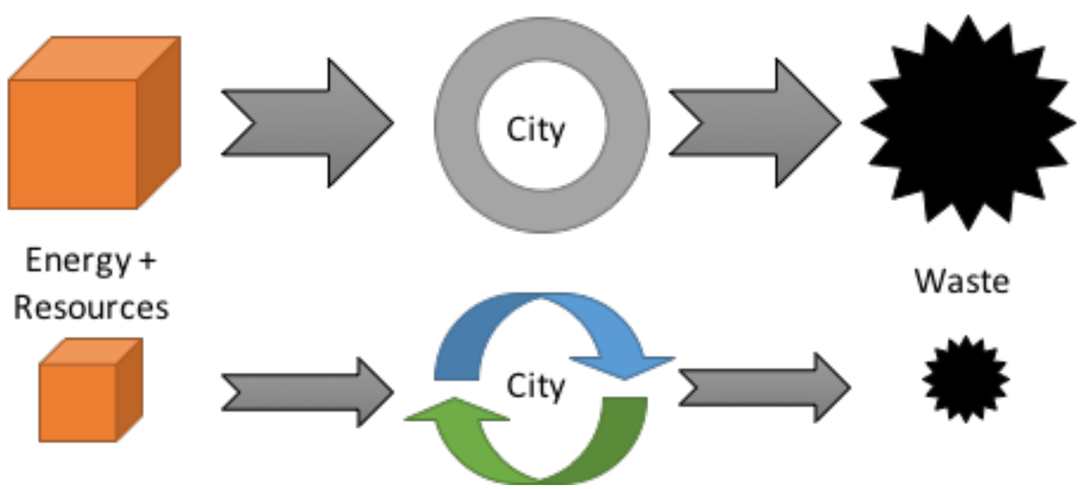


Figure 4: Linear Material Flow (Top) and Quasi-Circular Material Flow (Bottom) (source: author)

A new economic model based in sustainability and human relationships is perfectly aligned with Geddes' call for biotechnics and biocivics to propel humanity out of the Mechanical Age, a sort of "happiness economy" using a steady-state economy as its foundation (Gilding 2011). Even John Maynard Keynes (1945), one of the most influential economists of the modern era seems to advocate for this more holistic approach to living, writing

> "the day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems — the problems of life and of human relations, of creation and behaviour and religion" (quoted in *The Arts Council of Great Britain First Annual Report 1945*, 2).

Economics alone without civic ethics and a de-emphasis of growth for growth's sake was not enough, even for Keynes. Growth-obsessed economies are usually slaves to the all-mighty Gross Domestic Product (GDP), but this measurement of economic activity does not distinguish between positive and negative expenditures, and chasing growth above all else will not achieve harmony between humans and the Earth (Lovins, et al. 2006, 157). Instead of chasing exponential economic growth, planned slow growth, as suggested by François Grosse, can help us move to *la croissance quasi circulaire*, almost circular growth (Grosse 2014). Recycling rates above 80% have been said to be necessary for this type nearly circular economy, in order to stave off the depletion of natural resources (Grosse 2014, 59; Lehmann 2012, 321).

4.5: Summary of Themes

This section synthesizes and reiterates themes found from the research I conducted on Geddesian technics and civics theory. Most importantly, the characteristics of a biotechnic frame will be the basis for analyzing landfill mining in chapter 5, in order to preliminarily answer research question Q3 (Can Geddes' biotechnic approach to planning provide an effective alternative frame for MSW management?).

4.5.1: Geddesian Theory as Concrete Guide for Praxis

Although Geddes' writings are often criticized as too abstract or theoretical, unstructured, confusing and riddled with obtuse references, he hoped his work would be actionable (Young 2017). He hoped for a "feedback between research and practice" and completed numerous plans for cities in India, Pakistan, Israel, and elsewhere to apply his methods and theory (Ziffren 1972, 43; Hysler-Rubin 2011). Likewise, while he was highly critical of many symptoms of the Industrial Revolution that made cities deplorable, Geddes was in no way a Luddite. With his natural science background, Geddes wholeheartedly encouraged others "not to be afraid of science" and to look to the many benefits of modern marvels in biology, chemistry, and agriculture (Meller 1993, 143). In order to "dispel fear" of science and utilize the beneficial aspects of modern technology, Geddes established his notion of "civics," in many ways to temper either polar reaction to the quickly changing world (fear of progress or obsession with progress) (Meller 1993, 143-144). With this in mind, it is possible to identify Geddes as a researcher and practitioner with a *praxis*-based approach to studying and improving how humans use and are affected by science and technology—a participatory planner influenced by what we now call "Science and Technology Studies," or STS.

4.5.2: Characteristics of a Biotechnic Frame

The following items characterize a biotechnic frame, and can be used to evaluate both the technic and civic aspects of sociotechnological systems. These characteristics will also be the basis of my case study evaluation of landfill mining in the following chapter. The following questions should all receive a "yes" answer for a practice is to be considered truly biotechnic:

1. Is the practice self-sustaining long-term?
2. Is the practice transdisciplinary?
3. Does the practice encourage citizen participation and expertise?
4. Is the practice place-based and context-specific?
5. Are there built-in feedback loops to adapt the practice over time?
6. Does the practice value life above everything else?

The last condition is the most important concern, containing the other conditions underneath its umbrella. As discussed previously, while it may be hard to imagine sociotechnological systems that meet all the criteria framing planning through these questions will continually push us farther towards a more biotechnic society in which our militant peace is fiercely defended by everything we do.

4.5.3: The Necessity for a Higher-Order Theory to Unify and Revolutionize

Recycling cannot be the only solution, and we cannot repair the metabolic rift by working on only one scale. In fact, using a frame that posits a single answer to the waste problem is drastically incorrect; we will need holistic plans that attack all steps of the production and consumption of materials. The different scales within which the zero-waste movement, urban metabolism studies, and circular economy studies operate should and can be unified under a biotechnic frame. Policies must also aim at changing the "throwaway culture" and targeting the largest segments of the United States' waste stream, agricultural and mining wastes. Technologically, "it is already possible" but "the behavior change needed for zero waste...still lags behind" (Crocker and Lehmann 2012, 391). And what about all the waste that has already been throw away in the last 150 years since major U.S. industrialization, the resources sitting in landfills around the country (and world)? One promising process, landfill mining, will be discussed in further detail in the following chapter.

CHAPTER 5: CASE STUDY: DOES LANDFILL MINING FIT A BIOTECHNIC FRAME?

Landfill mining (LFM) is a technology that spans a variety of activities, can achieve differing and multiple objectives, and ultimately become a key piece of moving towards zero-waste and circular, metabolic economies. Because of its variability, a single definition for landfill mining is not yet accepted among scholars, but one of the most frequently cited definitions has been offered by Krook, et al. (2012). They argue

> "landfill mining could be described as 'a process for extracting minerals or other solid natural resources from waste materials that previously have been disposed of by burying them in the ground'" (Krook, et al. 2012, 513).

In essence, landfill mining is exactly what is sounds like: taking materials out of landfills and using them for any purpose other than re-burying them. This involves utilizing various methods to eventually re-introduced the inherent value of the material back into the economic and environmental metabolism of a community. Recently, some have argued that a new category, *Enhanced* Landfill Mining (ELFM), ought to be considered separately from LFM based on differences between their goals and processes. Jones, et al. (2013) defines ELFM as:

> "the safe conditioning, excavation and integrated valorization of landfilled waste streams as both materials and energy, using innovative transformation technologies and respecting the most stringent social and ecological criteria" (45).

The foremost organization in landfill mining, the European Enhanced Landfill Mining Consortium (EURELCO), has also adopted this definition for ELFM (EURELCO 2017). For the purposes of this study, it is not necessary to distinguish between LFM and ELFM explicitly; the general processes for both are the same and vary only by degrees and goals. Those engaged in discussions around LFM and ELFM all tend to agree that it is capable of being an integral part of a circular economy, as discussed in the previous chapter, but the field is still relatively nascent and much work is left to be done to fully incorporate LFM into our production, consumption, and waste management systems. In fact, between 1998 and 2008, only twelve articles on landfill mining had been published in peer-reviewed journals and only 39 in total between research papers and conference proceedings (without considering "gray literature," or practitioner knowledge in trade journals and less scholastically rigorous forums) (Krook, et al. 2012, 513-514).

This chapter will detail the general process of landfill mining, go on to discuss benefits and limitations that have been identified in the literature as well as the gaps in knowledge, and provide an overview of what current projects and actors are influential in the continued growth of this field. All of this research will then be analyzed for its adherence and compatibility with a biotechnic frame, as discussed in Chapter 4.

5.1: The Ins and Outs of Landfill Mining

The process of landfill mining is fairly straightforward, and can be broken down into six steps, or components. These steps include: 1) site assessment, survey, and waste characterization; 2) extraction; 3) valorization and processing/sorting; 4) transportation to further processing and end markets; 5) remediation; and 6) redevelopment (Fisher 2013, 4). While the first widely cited example of landfill mining occurred in Tel-Aviv, Israel in 1953, the process was not reproduced elsewhere until limited attempts in the United States in the 1980s (van der Zee, et al. 2004; Savage 1993). Other landfill mining projects, such as the Delaware Solid Waste Authority's projects in Kent and Sussex Counties, or the Normandy Landfill Reclamation Project in Beirut, in concert with increasing emphasis on recycling and resource recovery nationwide brought landfill mining to the attention of landfill managers again (Greedy 2016). These early attempts were scattered, often concerning a single landfill and untaken primarily as a means of site remediation rather than in an effort to recover resources (van der Zee, et al. 2004).

Because LFM is a relatively young field of research and practical pilot projects, the primary bulk of research has been targeted at the first stage to determine effective and feasible projects to pursue (Krook and Baas 2013, 3). Additionally, since steps five and six, remediation and redevelopment, have long histories in other projects, notably in the United States through the EPA's Superfund program, many researchers in working with LFM have determined not to focus on the exact end-processes specific sites may take (Krook, et al. 2012, 516).[19] I will not focus on these final two steps heavily in this section, but the question of where to draw the system boundaries for an LFM operation is one of the key outstanding questions in the development of theory in the field, and will be explored more later in this chapter (Herman, et al. 2014; see section 5.4.1.5 for a more in-depth discussion of system boundaries).

5.1.1: Site Assessment

During the first step, the actual waste composition and location of a specific landfill must be determined in order to proceed with other feasibility studies. Characterizing municipal solid waste (MSW) is first done by examining any records or logs of historic waste amounts and dumping locations within the landfill (Jones, et al. 2013). Then, physical sampling is completed, in much the same way that soil samples are bored, or can be completed with heavy machinery such as grab

[19] The colloquially-known Superfund program provides guidance and funding for the clean-up of sites that have been contaminated by hazardous wastes. The EPA's statutory authority for the program is derived from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and has been in operation since 1980 in the United States (EPA 2017).

cranes (Jones, et al. 2013). Sampling at the Remo landfill in Belgium was completed using grab cranes; the process can be seen in Figure 5 (Quaghebeur, et al. 2013). By examining the waste at regular depth intervals, the accuracy of any existing logs can be validated and a spatial picture of waste begins to emerge (Jones, et al. 2013).

Figure 5: Sampling and Characterization at Remo Landfill in Belgium

A) Crane grab collects samples from landfill; B) Sample deposited in bucket of wheel loader; C) Sample deposited in container in a layer of even thickness; D) Grid overlaying waste sample to be characterized

(source: Quaghebeur, et al. 2013)

5.1.2: Extraction

Next, the economic, ecological, and societal consequences of landfill mining are weighed by the LFM operator and if the determination of feasibility is made, extraction of waste can be accomplished with much the same tools and techniques of standard earth-moving operations. Excavation is “a relatively simple [step] for an experienced landfill or mining operator,” and no new technology of processes need to be developed to specifically remove MSW from landfills (Fisher 2013, 4). However, the excavation step presents the largest risks in most LFM operations, especially to those laborers working on the site. Uncertainty is high in this stage, and the potential for discovery of hazardous materials could be a serious cause for concern (Fisher 2013, 4). Additionally, care must be taken during excavation to minimize particulate matter, noise, and other environmental nuisances and pollution (Jones, et al. 2013).

5.1.3: Valorization

The third step in landfill mining (valorization, processing, and sorting) is in many ways the most defining part of the process for LFM. Valorization is “refers to any process that aims to convert waste materials into more useful products by reusing or recycling them (material recovery), or converting them into an energy resource” (Rada 2016, xvii). In landfill mining, valorization more specifically refers to the process of separating waste into the streams in which they will be most valuable to recycle or remanufacture.

Depending on the composition of excavated waste, it will be split into constituent components through the use of manual or mechanized sorting equipment, which may include screens, sifters, magnets, or density separation of materials in liquid mediums, among other methods (Jones, et al. 2013, 50). High-integrity recyclables such as aluminum and copper can be selected and separated for recycling and re-manufacturing; it has been shown that even "simple excavation and screening equipment...demonstrat[es] moderate performance in obtaining recyclables in terms of salable material and energy resources" (Krook and Baas 2013, 2). Organic matter can be diverted for composting or as an input for refuse-derived fuels (Krook, et al. 2012; Kurian, et al. 2007). Portions of the waste destined to be utilized in a waste-to-energy application will likely require shredding at this point to increase uniformity as well as even drying to aid in combustion if incineration is the preferred/available technology (Fisher 2013).

Valorization, the process of using waste as either material or as the input to create energy, occurs based on the composition of the waste excavated, as well as external factors such as marketability and technology constraints (Bosmans, et al. 2013). Much research in LFM to this point has focused on the question of valorization. Studies evaluating numerous waste-to-energy technologies for their performance with previously-landfilled MSW have not determined a blanket method that is the most economically or environmentally viable in all cases, but one of the most promising is plasmagasification of waste. Plasma-based technology has only been applied to waste relatively recently and involves the anaerobic heating of waste in a reactor with charged electrons and gaseous substances (Bosmans, et al. 2013). Synthetic gas, or syngas, is produced in the process and can later be burned virtually clean; at the same time, “inorganic waste material” solids are captured “in a vitrified, non-leaching slag” (Bosmans, et al. 2013, 20). Vitrified slag can later be used as an aggregate for construction materials or potentially as a high-end secondary finish product like has an appearance similar to obsidian (Bosmans, et al. 2013, 21-22).

There is potential that some percentage of excavated waste is unable to be processed. This can be the case for streams of waste that are either unable to be processed due to technology gaps or due to being unprofitable to recycle (Geysen 2013). A concept for “temporary storage” of such materials has been developed to be implemented at the Remo landfill site in Belgium (Geysen 2013; see section 5.2.2.3 for a more in-depth description of this process).

5.1.4: Transportation to Remanufacturing and Processing

The fourth stage of landfill mining projects, transportation to end markets moves the sorted and processed waste in separate streams to each appropriate transfer station, distribution point, or buyer. Energy produced (either by an on-site waste-to-energy plant of some sort or offsite at a regional plant) can be distributed to customers. Recyclable streams can be transported to buyers who plan to re-manufacture products using secondary materials rather than primary virgin materials. Of primary concern during this step of LFM is the safe transport of processed waste (Fisher 2013). One issue that often introduces uncertainty into assessments of potential LFM projects are the availability of end markets for recovered materials (Krook and Baas 2013). Van Passel, et al. (2013) found in their research that the economic viability of many LFM projects hinges on the market structures and commodity prices for materials, and uncertainty in these factors is highly limiting for decision makers looking to implement LFM. Without reliable buyers for secondary materials close to the site of LFM, or at least within the region, often the additional sorting, cleaning, and processing that must be conducted with excavated waste makes it economically infeasible to successfully complete a project (Van Passel, et al. 2013).

5.1.5: Site Remediation and Redevelopment

The final two steps of LFM processes, remediation and redevelopment will not be covered in depth by this study, but offer some of the most exciting aspects of landfill mining's potential for benefit. As mentioned previously, traditional land remediation methods would apply after the removal of the source of pollution, in this case most likely waste leachate (Fisher 2013). Although some landfill mining projects are undertaken in order to recapture or increase the capacity of the landfill in order to extend its period of use, many landfills in denser urban areas may become prime pieces of real estate after excavation and remediation (Hogland, et al. 2004; Fisher 2013). Whether the draw is profit from land sales, or space for new infrastructure, covering and closing a landfill is far inferior an option to having land without waste underneath it. Raga, et al. (2015) investigated a project near Modena, Italy where a portion of a MSW landfill was excavated and redeveloped to support a high velocity railway line between Milan and Bologna.

5.2: Potential Benefits of Landfill Mining

The benefits of landfill mining are layered and numerous, but they fall into three broad categories: *ecological*, *economic*, and *social*. As Greedy (2016) notes, some of the drivers of LFM are potential revenue sources, while others can help achieve wider sustainability goals (Greedy 2016, 2). While many projects only focus on one or two aspects of LFM to support implementation, a holistic approach could, at least seemingly, achieve extra synergies that have been unrealized in smaller applications (Greedy 2016, 1). In the following sub-sections I describe in greater detail the many potential benefits of LFM that could be layered and combined to enhance the ecological, economic, and social aspects of a community.

5.2.1: Ecological Benefits of Landfill Mining

Many ecological benefits can be derived from landfill mining, either as goals unto themselves or in tandem with other economic or social goals. I treat each one of these benefits within separate headings below, but they should be understood as overlapping and strengthening each other.

5.2.1.1: Mitigating Climate Change

As mentioned in Chapter 1, the climate change impact of landfilling waste is dramatic, producing methane and contributing to global temperature increases. In Europe, policy discussions surrounding the internalizing of externalities created by private companies have already begun to consider LFM as a potential instrument to address climate change (Laner, et al. 2016, 6882). LFM shows "potential for mitigating global warming and the various kinds of pollution related to conventional energy generation and mining activities" (Frändegård, et al. 2013b, 742). Unfortunately, there are only a few landfill mining case studies available to date that investigate the climate impact of LFM operations, and they reach differing conclusions (Laner, et al. 2016, 6882-6883). One study in Sweden found that conducting LFM at the same time that a high-risk landfill was being remediated could lead to 30 million tons of avoided GHG emissions (Frändegård, et al. 2013b, 752). Another study found that the categories they measured in relation to climate change "are always influenced adversely by ELFM" (Danthurebandara, et al. 2015, 444). The opposing results most likely do not falsify one another, but more likely lend credence to the conclusion that "case-specific factors and settings" affect the outcome of evaluation (Laner, et al. 2016, 6883). Thus, in some contexts where the energy system is especially reliant on fossil fuels rather than renewable energy sources, landfill mining might significantly reduce GHG emissions (Frändegård, et al. 2013b, 751). One of the most compelling reasons to consider LFM is also one of the ones that is the most context-dependent in terms of it ecological benefit, and, therefore, context must be heavily considered when deciding whether or not to implement the operation.

5.2.1.2: Reversing Habitat Loss and Increasing Biodiversity

Habitat extinction and resulting loss of biodiversity are problems intimately related to the metabolic rift described by urban metabolism scholars. Biodiversity is "the characteristic that sustains [the] complex and efficient system of metabolism" around which natural systems operate (McDonough 1993, 4). The symbiotic nature of millions of diverse organisms is an integral part of the urban metabolism that has experienced a rift since un-checked industrial growth took precedence over life. Cities especially suffer from "poor provision of ecosystem services," which are the "conditions and processes by which natural ecosystems and species that they represent sustain and fulfil the human life" (Burklakovs, et al. 2016, 7). In addition to urbanization and loss of green space, climate change also impacts the loss of biodiversity (Lehmann 2010, 28).

In an effort to restore habitat and increase biodiversity, LFM can provide the drivers to complete site remediation (Burklakovs, et al. 2016, 7). However, it must be noted that during the process of landfill mining, which can take years, short term loss of habitat could be experienced. Jones, et al. (2013) describe the Remo landfill site in Belgium as "currently consists of dry siliceous grassland, dry heath and wooded heathland ecosystems, which have gradually developed after completion of landfill mining services" (53). To complete a full LFM process, the site will temporarily experience a loss of habitat, although gradual restoration is possible upon the completion of the project (Jones, et al. 2013, 53). In an effort to increase biodiversity and wildlife habitat to pre-degradation levels, it may be necessary to experience a short-term loss of habitat during LFM. This balancing of priorities points to the complexity of both MSW management and LFM in particular. Any landfill mining operation should necessarily complete a thorough environmental impact assessment in order to balance short-term on-site habitat loss with positive long-term off-site effects that can be achieved (Jones, et al. 2013, 54).

5.2.1.3: Hazardous Waste Clean-up and Remediation

Remediation of sites contaminated by hazardous wastes is a top priority for many public agencies, and in the United States is overseen by the EPA through its Superfund program, discussed previously. Much work in planning and engineering has already gone into understanding the benefits of remediating a site from hazardous residual materials, and even most of the landfill mining projects undertaken in the U.S. during the twentieth century were focused on “solving local concerns such as conservation of landfill space, remediation or other traditional waste management issues” (Frändegård, et al. 2013a, 24). In order to properly remediate toxic sites, however, “the fate of pollutants, transport mechanisms in soils, and contaminant characteristics are parameters” that “must be known” (Hogland, et al. 2004, 119). Because many unknowns still exist when considering a specific landfill’s potential to contain hazardous material, several studies have undertaken Monte Carlo simulations to more appropriately quantify this risk (Frändegård, et al. 2013a; Frändegård, et al. 2015).

5.2.1.4: Water Quality Management

Due to increasing population, urbanization, and industrialization, water shortages, along with food and resource shortages, will increasingly threaten the world in the twenty-first century and beyond (Lehmann 2010). Water is a key input for all living systems, human and non-human, and balancing fresh water resources is another requirement of a functioning urban metabolism. Harkening back to Small’s (1970) concept of the “Third Pollution,” addressing water quality and availability means also addressing solid waste pollution of those systems. As expressed in Chapter 1, groundwater and surface water can be at risk from landfill leachate contamination (Fisher 2013). Remediation is often intimately tied to not only soil but to water as well (Hogland, et al. 2004). Much like with potential biodiversity and habitat benefits, water quality benefits can actually be worsened during the process of LFM itself; there is a threat to groundwater aquifers and source water contamination “during excavations, storage, transportation, recycling of material, and handling of hazardous waste, mostly during intense rainfalls” (Hogland, et al. 2004, 124). Here again careful on-site management must be undertaken to prevent any contamination from LFM operations, but especially with landfills that contain high amounts of electronic waste (e-waste) the net impact is expected to be positive for water quality (Lehmann 2010).

5.2.1.5: Decreasing Virgin Material Extraction

Virgin material stocks of resources and especially metals are finite within the earth’s system boundaries. Extracting these metals and minerals has “severe” “social and ecological consequences” (Johansson, et al. 2017, 46). More “efficient” technologies such as mountain top removal cause disastrous consequences for ecosystems as they seek out small quantities of resources dispersed over greater areas. However, “even if the evolution of technology is able to facilitate access of less and less concentrated deposits, the economic and environmental costs of marginal resources are elevated more and more” (Grosse 2014, 67; translation my own). For some metals landfill mining will not fully repair the metabolic rift and the damage that has already been caused. Recycling rates for steel, copper, lead, and aluminum are already high and therefore unlikely to increase significantly with LFM operations in countries with established recycling infrastructure (Johansson, et al. 2017, 46). While the details of how long any particular resource will last in the earth's crust, most scholars agree that stocks will not last forever and that the rate with which we produce goods outpaces our ability to simply recycle materials indefinitely (Grosse 2014). For copper, secondary production (i.e., using recycled material) only represents 30% of total global production (Johansson 2016, 4). Yet the amount of copper estimated to be contained in waste deposits is equal to the amount of copper estimated to be in the "technosphere" (Kapur 2006). Mining landfills for the resources they contain, when done in conjunction with other LFM activities, can only minimally help fill the gap if production growth goes unchecked (Johansson, et al. 2017, 46). However, as Johansson (2016) argues, "compared to traditional mines, deposited materials in a landfill are more refined and significantly closer to the market" and avoid the GHG emissions created from traditional mining enterprises to boot (26). Thus, there are great potential benefits to using landfill mining as a way to decrease the amount of virgin material stocks we extract.

5.2.2: Economic Benefits of Landfill Mining

Several types of benefits can be derived from landfill mining that I have placed within an "economic" category. Note that this economic category reflects the narrow current popular definition of economics, not the broader economics that Geddes called for that I discussed in Chapter 4. As part of my analysis at the end of this chapter, I will discuss whether the economic benefits of LFM are appropriate within the frame of biotechnics.

5.2.2.1: Revenues from Energy and Material Sales

The obvious economic advantage of landfill mining comes first from profits resulting from the sale of energy and materials mined. In the same way that recyclers sell back materials to be re-manufactured into new products, landfill miners can sell materials mined to the same clients. The most profitable set up for materials and energy sales will depend on specifics of the landfill, and is especially sensitive to transportation costs and electricity costs in the area (Gusca, et al. 2015). For each landfill, additionally, the composition of its material stream will determine what avenue for energy and materials sales makes the most sense. The age of the landfill can be a good indication factor for potential material composition. U.S. landfills accepting waste before the material and consumption revolution of the 1950s (see Chapter 3) contain "very little materials of high economic value," while landfills in operation beginning in the late 1980s and onward have waste streams that are likely less profitable due to increases in recycling and residuals incineration (Van Passel, et al. 2013, 95). High-value low-degradation materials, like metals and plastics, are often the best target for materials re-sale (Fisher 2013). For plastics bags specifically, however, recycling is difficult because normal cleaning techniques are not well-equipped to remove impurities on bags excavated from landfills (Zhou, et al. 2014). Because there is uncertainty in material composition, to feasibly conduct an LFM operation, "affordable and accurate prospecting methods are fundamental" (Krook and Baas 2013, 4). As Johansson (2016) notes, however, depending on political and institutional policy goals, it may be appropriate to undertake landfill mining "regardless of what is profitable today" in order to make long-term investments and meet changing priorities (37).

5.2.2.2: Redevelopment Value of Landfill Site

One of the major posited revenue streams for landfill mining is the potential for creating developable real estate that has a higher land value than when the site was merely a landfill. In fact, "the value of the land commonly exceeds the value of the content" according to Burklakovs, et al. (2016). Developers are most interested in mining landfill sites that can produce a high rate of return on investment, and thus the surrounding land uses are important to consider when undertaking an LFM operation that hopes to achieve this benefit. "Sites may be in locations that are, [were] it not for the landfill operations, ideal for traditional development purposes" and in those cases development might be a primary driver of economic feasibility (Fisher 2013, 2). Data on market value of landfill sites can be difficult to determine or simply unavailable, however, since comparing the (most likely decades old) pre-landfill land value with current value is often not possible (Marella and Raga 2014). In some cases, rather than redeveloping an entire site, a portion may be subject to LFM, as was the case for the RSU landfills of Modena, Italy that are now traversed by a high velocity train line (Raga, et al. 2015). Land reclamation was found to be one of the top three benefits from landfill mining by Zhou, et al. (2015) in their study of the Yingchun landfill in China, and depending on market conditions could be the determining factor in a project's economic feasibility.

Site specific factors determine whether the site of the former landfill can support certain uses and density levels such as housing areas (Baas, et al. 2010), but the possibilities here are exciting, particularly from an environmental justice perspective. In the United States, an historic pattern of siting landfills in poor and/or minority communities has resulted in an unacceptable disproportionate impact with numerous closed sanitary, hazardous, and unregulated landfills (Mohai and Saha 2007). If landfills, currently a source of environmental injustice for many communities, could instead be redeveloped to be a public good, this benefit of landfill mining may be able to serve as a form of reparations for a history of neglect and injustice.

5.2.2.3: Additional Landfill Capacity

In some regions, there may be significant reasons to complete an LFM operation with the goal of opening up additional landfill capacity. Opening up additional landfill capacity can have short-term or long-term economic benefits, depending on the specific needs of the site. At the REMO landfill in Belgium, part of overall plan for LFM operation at the site is a cyclical approach; the landfill has been divided into four “cells” that will rotate between being mined and being re-filled with wastes that at the current point in time are not economical enough to put to reuse (Geysen 2013). The Remo site will eventually valorize and process all of the waste and no longer be a working landfill, but in the meantime temporary storage will allow the landfill to be mined while technology necessary to process certain materials is still being developed (Geysen 2013).

For an example of a long-term benefit from increasing capacity, ecomaine’s landfill is a good example, though not one from MSW. Extending the life of this particular ashfill in southern Maine through LFM resulted in “additional airspace [that] was estimated to be worth $267,000” (Wagner and Raymond 2015, 455). This additional value of increased airspace comes from the revenue that can be obtained through tipping fees for waste that previously could not fit in the landfill

(Burklakovs 2016). Finally, as Fisher (2013) notes, there may be types of waste that are more suitable for long-term storage in landfills, “such as non-reactive hazardous wastes (e.g. asbestos),” and increasing the capacity through landfill mining may create a more suitable final resting place for those materials (3).

5.2.2.4: Local Economic and Material Security

Many materials and resources in use in the global economy today come to the U.S. from many thousands of miles away. The predominant frame in resource security studies works to ensure the long-term stability of complex global supply chains and markets, but for a growing number of scholars, security is focused more on ensuring localized sources of critical raw materials independent from other economies (Wagland 2016). Increased resource scarcity results in rising prices for input stocks and increases the costs of production (Wagland 2016). Landfill mining has the potential to reduce reliance on non-local economies and dwindling supplies of critical raw materials (Wagland 2016). Resource uncertainty historically leads to bloody conflict and full out war (Tabb 2007; Klare 2001). The benefits of localized reserves of important metals and minerals such as those contained in many landfills should not be scoffed at or undervalued. As William Tabb (2007) writes,

> “how we respond to these resource pressures will determine what kind of society we shall have and what sort of planet ours will be” (41).

5.2.3: Social Benefits of Landfill Mining

Landfill mining also includes several benefit categories that most directly speak to the quality of life for those residents in the surrounding community. As with both ecological and economic benefits that can be realized through landfill mining, social benefits, as I have termed them, are not entirely distinct from the other two groups of benefits. Social benefits are at this point in time the subject of much further research by scholars in the field, as making decisions about whether or not to undertaken a LFM operation are often based on incomplete data that has inherent difficulty in properly accounting for social benefits. A research team out of Austria has been attempting to develop clearer decision making tools that better incorporate the social benefits of landfill mining (Hermann, et al. 2014; Hermann, et al. 2015; Hermann, et al. 2016). The problem of properly accounting for the public good is not a new one, but more work needs to be done to fully understand the potential each of these benefits hold.

5.2.3.1: Enhanced Public Health and Safety

As previously discussed, landfills can pose “significant environmental and health risks” (Johansson 2016, 5). Many of the environmental benefits discussed in sub-section 5.2.1 include corresponding benefits for community members, such as in the clean-up of hazardous waste and its corresponding positive impact on public health. Climate change threatens many coastal landfills with erosion and resultant contaminant leeching, and strategic planning for these at-risk sites could include landfill mining as part of stabilization and remediation (Carrington 2016). Especially in terms of risk reduction as a tactic of resiliency and sustainability, landfill mining can eliminate or mitigate threats to the community. As planners have an ethical professional mandate to protect the health and safety of their communities, this benefit may be the biggest driver of all for considering landfill mining. , but getting industries to internalize their own negative impacts has proved more than difficult in our neoliberal economy.

5.2.3.2: Beautification and Recreation Opportunities

Alongside the ecological benefit of increasing biodiversity and wildlife habitat, creating open space that a community can use for recreation purposes is one more benefit of landfill mining. Outdoor recreation opportunities and public space provision have been an integral part of the work of urban planners all the way back to Frederick Law Olmsted (1870), who advocated for parks to be the centers of industrialized cities in order to provide escape from the grind of daily life (in Sutton 1997). Although few can deny the multitude of benefits that come from recreation easily accessible to urban areas, it can be difficult to quantify the potential value in monetary terms that decision makers can point to for validation. Though in theory impacts such as increasing “recreation and nature reserves” can “be assigned a monetary value” for use in calculating a landfill mining project’s overall impact, differences in preferences and willingness-to-pay between individuals can vary widely (Van Passel, et al. 2013, 96). This area of study has only barely begun to develop; one study by Damigos, et al. (2016) found that although over 95% of residents in a rural Greek town “recognized the need for LFM operations,” only a quarter were willing to pay through taxes. Funding such remediation projects is difficult in our current neoliberal economy, which lacks the funding mechanisms for such projects after decades of deregulation.

New York City is home to an apt current example of a landfill being transformed into open recreation space. Fresh Kills municipal landfill was opened in Staten Island in 1948 under infamous urban planner Robert Moses and “is the largest human-engineered formation in the world” (Klenosky, et al. 2017; Melosi 2016, 59). After operating for over five decades, the landfill was closed in 2001 and plans to remediate and reopen the site as Freshkills Park were announced in 2003 (Trumpeter 2012). The master plan includes stabilizing, capping and re-vegetating the former landfill “with native grasses and wildflowers,” and adding educational programs, goats, trails, sculpture, and solar panels to the site (National Recreation and Park Association 2011). When completed, Freshkills Park will be nearly three times the size of Central Park (Klenosky, et al. 2017). Melosi (2016) questioned whether the ecological restoration agenda obscures the site as a symbol of “a reflection of our material culture, our consumerism, our acquisitiveness, and our sense of value and worthlessness," and suggests that perhaps in this case the site should be considered from a historic preservation angle (60). Although the landfill is not being mined, this case study provides an example of the ways that "a new 're-use' look at landfills" can increase recreation and open space opportunities, especially in hyper-dense urban centers (Baas, et al. 2010, 176).

5.2.3.3: Local Green Job Creation

In many ways intimately tied to economic benefits of landfill mining, the creation of local green jobs that can be attributed to projects is another social benefit. Creation of jobs locally is of high priority for many policy makers and politicians (Johansson 2016). At the Remo Landfill discussed previously, the number of new jobs created by the landfill mining operation is estimated at around 800 jobs from operating the waste-to-energy plant and energy-to-culture horticultural activities (Jones, et al. 2013). It is already demonstrated in other green industries that the "green" way typically creates comparably more jobs than "business as usual;" Howland (2007) shows this in the brownfield remediation industry and Lehmann (2010) shows this in the waste separation and recycling sectors. Resource-intensive industries, such as traditional mining, are less likely to lead to new job growth than "circulation practices" that are quite a bit more labor-intensive (Johansson 2016, 3). Finally, the new jobs will be based in the region that the landfill is a part of; rooted labor tied to specific places is not an easy achievement in the global economy, where labor and technology can be transported to any location to complete the service or production.

5.2.4: Benefits Expressed by Survey Respondents

Although an appropriate threshold of survey responses was not reached in time to include any data from it as conclusive or significant evidence, I believe that there is still value in reporting portions of it with a caveat. In this section I briefly include direct responses from the three submissions I did receive to add additional support to the evidence of benefits captured by the literature on landfill mining. two respondents indicated they work in the private sector and one indicated they worked in the public sector. The respondents were asked to indicate the relative importance of given ecological, economic, and social benefits that were identified in literature on landfill mining. Responses were recorded along a four-part Likert scale, including “not at all important,” “slightly important,” “moderately important,” and “very important.” The results I present below are incomplete and only preliminary, but they do show three real views on the benefits of landfill mining from those working in the field.[20]

---

[20] Full data is available from the author/primary investigator upon email request.

5.2.4.1: Relative Importance of Ecological Benefits

When asked to rank the relative importance of the benefits that can come from landfill mining, all three respondents agreed that water quality management was a “very important” benefit. “Climate change mitigation” and “decreasing overall virgin material extraction” were answers that were also “very important” to two out of three respondents. In the case of “climate change mitigation,” the third respondent marked this benefit as “moderately important.” In the case of “decreasing overall virgin material extraction,” however, the third respondent considered it to be “not at all important.” Less decisively important was “increasing biodiversity / wildlife habitat,” with two out of three respondents marking it as “not at all important” and one marking it “very important.” Finally, “hazardous waste clean-up / remediation” was “very important” to one respondent, “moderately important” to a second respondent, and “not at all important” to the third respondent.

5.2.4.2: Relative Importance of Economic Benefits

Regarding economic benefits, two respondents said that “developing real estate to sell” was “not important at all,” while one said that it was “very important.” Both “increasing the independence of local economies” and “decreasing dependence on raw materials” received two “very important” responses and one “slightly important” response each. Other responses received a mix of ratings, with no clear preference emerging among respondents. “Profits from sales of energy or materials” received one response in each of the lowest three ranks. While “addressing shortage of landfill capacity” was “very important” to one respondent, it was only “moderately important” to another respondent and “not at all important” to the third respondent.

5.2.4.3: Relative Importance of Social Benefits

Social benefits appear to be the most important to the respondents overall. Two out of three respondents ranked “enhancing public health,” “enhancing public safety,” and “creating local green jobs” as “very important.” Additionally, the third response for each of those three benefits was in the second highest rank, “moderately important.” No respondent considered “increasing recreational opportunities” to be a very important benefit of landfill mining; instead responses were split between the lower three ranks. Respondents seemed mixed on the importance of “beautification / aesthetics,” with one marking it “very important,” one marking it “moderately important,” and one marking it “not important at all.” One respondent chose to add in that “public education” is a “very important” benefit of landfill mining.

5.3: Limitations and Obstacles for Implementing LFM

For all of the benefits that can be derived from landfill mining, there are also a number of limitations and obstacles that must be considered prior to beginning a project. This section explores limitations and barriers identified in the literature that prevent the widespread practice of landfill mining today.

5.3.1: Excavation Risks: Occupational and Ecosystem Health and Safety

Many risks of landfill mining are similar to traditional mining operations, but are "enhanced by the heterogeneous nature of the wastes in a landfill" (Fisher 2013, 3). This includes the unknown potential that a specific landfill contains hazardous materials, which pose a risk to the safety and health of both worker and ecosystem. It is anticipated, therefore, that a "safety and health plan involving procedures for management of hazardous waste, systematic monitoring of air quality, trained and well-equipped workers," etc. would be a basic requirement for undertaking an LFM operation (Krook, et al. 2012, 515). Most studies in the field have concluded that occupational risks are relatively low, with the greatest risk coming from violent escaping of gasses at the bottom layers of landfills (Krook, et al. 2012). Typical landfilling operations pose similar risks to those of landfill mining (Fisher 2013). Thus, while occupational risks will always be present, it is likely that this barrier can be safely and appropriately overcome through a combination of regulation thorough preliminary compositional studies on potential sites of landfill mining.

Similarly, there is a risk to local ecosystems and communities during the LFM operation itself. Habitat may be lost during excavation, or leachate and gas may escape during regular operation (Fisher 2013). Methane leaks can lead to explosions and fires or flammable hydrogen sulfide gas, which can be fatal when inhaled, could be present (EPA 1997). Additionally, there is a chance of subsidence or collapse of cells adjacent to the one being excavated, and care must be taken to stabilize slopes (EPA 1997; Krook, et al. 2012). Therefore, environmental impact assessments should be conducted prior to excavating in order to determine the extent of potential risks and weigh these against the benefits. Life cycle analysis can help decision makers weigh the "difference between leaving the landfill to naturally degrade over an unknown period against the impact of the LFM project" (Fisher 2013, 7).

5.3.2: Technological Barriers

Technology for landfill mining has not yet been specifically developed. Instead, trommel and vibrating screens are utilized to separate soil from waste, which can be used as daily cover or filler material (EPA 1997; Krook, et al. 2012). However, these methods have been less effective in separating marketable recyclables from waste residuals (Krook, et al. 2012). Equipment purposely designed for sorting recyclables is better, but is meant to separate fresh waste prior to landfilling and still has difficulties (Johansson 2016). As Jones, et al. (2013) note, where sorting and processing technology has not yet caught up it may be best to keep waste "stored in view of future valorization, whenever technologies are mature and/or economic viability for the resource recovery procedure is ascertained" (47).

Most of the studies on landfill mining so far have focused on technology required to make landfill mining economically feasible, and there is still work to be done in this area (e.g. Bosmans, et al. 2013 for an overview of waste-to-energy technologies' role in LFM such as plasmagasification). Johansson, et al. (2017) argues that another one of the major barriers to LFM becoming widespread is the lack of reliable "prospecting" technology "to identify exactly where the valuable materials are located" in each site (48). Although most of the research has focused on this aspect as the primary barrier to investigate, it is likely the barrier current technology-focused frames are equipped to tackle.

5.3.3: Knowledge Barriers

The process of landfill mining requires long-term investment on the part of private companies and public entities, and yet, long-term profitability is principled on certainty and reliability. Unfortunately, information on the amount, type and location of materials in each specific landfill is "generally insufficient" (Wagner and

Raymond 2015, 451). Many outside factors cause the concentration of materials to be randomly dispersed throughout a landfill, including: “seasonal variations, age of the landfill, regulations (e.g., landfill bans), degree of diversion, and socioeconomic and macroeconomic factors” like economic downturns (Wagner and Raymond 2015, p .451). The kinds of testing and surveys that are necessary to make informed decisions are expensive and there will always be a measure of uncertainty associated with excavating old landfills. Knowledge barriers prevent LFM operators from knowing “whether the materials excavated will be marketable or not” (Fisher 2013, 3). At the same time, developing prospecting tools to better understand landfill contents also necessitates a standardized framework for evaluating all the “critical factors for economic and environmental performance” Krook, et al. 2012, 518).

Finally, the nascent state of landfill mining scholarship is itself a barrier in many ways to the implementation of LFM on a wide scale. In their comprehensive literature review of landfill mining literature, Krook, et al. (2012) found that from 1988-2008, only 39 scientific papers or published proceedings to scientific conferences explicitly dealt with landfill mining. Of course, in the past five years several more papers have been published and can be added to this number; however, it is clear that scholarly research on the field has only begun to develop. Further, “gray literature” such as trade publications, practitioner knowledge, and organizational guidelines were not included in the 2012 study by Krook, et al., and it is possible that more extensive insights are available in those sources, though they lack the same standards of rigor and trustworthiness that academic journals require. Bringing together both scholarly and non-scholarly information will be necessary in the future of LFM studies to broaden and deepen the fledgling field. Overall, scholars and practitioners must actively work to reframe the discussion of LFM from efficiency, cost-effectiveness, and feasibility to a fuller holistic approach that considers the socio part of the system equally alongside the technical.

5.3.4: Framing Barriers

Not only must technology, knowledge, and operational risks be addressed if landfill mining is to catch on. Planners and researchers must tackle what is potentially the biggest and most unknown obstacle: institutional framing of waste and landfills that prevent feasible LFM. Recent work in Sweden has begun to focus on institutional barriers to landfill mining that exist in the form of taxes, subsidies, regulations, and bans (Johansson 2016; Johansson, et al. 2017). These researchers argue that, following Unruh (2000), landfills have experienced frame “lock-in” from a variety of sociotechnological system components (Johansson 2016; Unruh 2000). The system of landfills involves actors, policies, governmental agencies, industry practices, waste treatment technologies, taxation schemes, communities, facts, financial investments, etc. (Johansson 2016). All of these individual system components have grown up together to “lock-in” the “dump regime” that frames landfills as a problem of final disposal for valueless materials (Johansson 2016).

As Hughes (1994) asserts, there is a reciprocal relationship between technology and society in which each influences the other. However, over time, as sociotechnological systems “become larger and more complex” they experience a sort of technological momentum, where they are “less shaped by and more the shaper of [their] environment” (Hughes 1994, 108). Systems with enough momentum are “difficult to stop and may in fact find ways to perpetuate [their] own existence” (Boslaugh 2011, 408). Landfills have gathered enough of this momentum that to redefine them as mines of valuable resources faces tremendous opposition. Using an even wider analogy, Kuhn’s (1970) theory of the structure of scientific revolutions is also applicable to the structure of revolutions in the waste management industry. Paradigms, akin to Goffman’s frames (1986), inform research into sociotechnological systems and influence those that come afterwards (Feenberg 2016, 283-284). Educational institutions also work to indoctrinate aspiring professionals to “actively resist challenges to orthodox methods” and frames (Kuhn 1970; Unruh 2000, 823). In much the same way, previous planning doctrine has prevented landfills from being considered anything other than a nuisance or a hazard.

One example of this is the ways in which we classify material in landfills as waste rather than as commodity. Waste has “restrictions on handling, movement, and transferability” while commodities are mobile and can be “moved, sold, and bought” (Alexander 2016, 35). This classification means that landfill mining has been difficult for authorities to interpret in the context of existing regulatory frameworks (Johansson 2016). Framing of waste here is key. Johansson, et al. (2017) found that when LFM was compared to remediation alone using a “pollution frame,” it was considered the better of the two alternatives, but when LFM was compared to traditional mining using a “resource frame” “the latter is considered to be a better option due to the limited resource potential in landfills” (50). This is especially important when it comes to financing LFM operations, as “secondary resources are partly penalized with strict market requirements...while primary resources are supported through subsidies” in many countries and jurisdictions (Johansson 2016, 81). Different planning frames for waste result in different preferred decisions, and therefore the frame used when arguing for specific LFM operations must be tailored to the specifics of each community and institutional framework.

Which agency maintains oversight is another important frame barrier when considering LFM. Just as no agency in the U.S. federal government was the single authority enforcing the Solid Waste Disposal Act until the creation of the EPA as an umbrella agency, authority over resource management is often split between primary and secondary resources (Johansson 2016). Consider the case of Swedish authorities for primary resource oversight (Swedish Geological Survey; SGU) and secondary resource oversight (Swedish Environmental Protection Agency; SEPA). For the SGU, according to Johansson, et al. (2017), "resource occurrence seems to be reason enough for supporting an activity" (52). In contrast, environmental benefits must be demonstrated with certainty for the SEPA to support an activity (Johansson, et al. 2017). This results in a higher threshold for scrutiny of LFM activities if they are to be considered alongside recycling and remediation efforts, but relatively little demonstrable environmental benefits if they are to be considered aside traditional mining activities. Once again, framing of landfills as either a stock of materials to be mined or as a hazard to be mitigated leads to wildly different outcomes from two different neoliberal categorizations.

5.3.5: Constraining Factors Expressed by Survey Respondents

Respondents were asked to consider what actors and groups actively support, remain neutral, or actively constrain their attempts to achieve the benefits of landfill mining. This question was asked regarding each broad category of benefits used earlier in the survey (i.e., ecological, economic, and social). I summarize emerging patterns below, with the understanding that responses do not yet meet standards for sample size and distribution.

5.3.5.1: Ecological Support and Constraint

When asked who would "actively constrain" their attempts to achieve *ecological* benefits derived from landfill mining operations, two out of three respondents believed that "neighborhood / community groups" and "individual residents / citizens" would worked against them. One respondent each indicated that they believed "colleagues" and "municipal / local agencies" would also actively constrain their efforts for ecological benefits. In contrast, two respondents thought that "state / provincial agencies" and "university scientists / researchers" would "actively support" ecological benefits they hoped to gain from landfill mining. No clear consensus developed regarding the following actors, with each receiving conflicting opinions from respondents: "international agencies (EU)," "national / federal agencies," "European Enhanced Landfill Mining Consortium (EURELCO)," "trade organizations," and "non-profit organizations." Several actors and groups suggested in the survey, including "private consultants," "vendors (e.g. equipment manufacturers)," "non-profit organizations," and "developers / real estate interests," were marked "not applicable" by two respondents each. This suggests that LFM is framed in such a way currently that respondents do not believe many of private and non-governmental actors are relevant in their goals for ecological benefits.

5.3.5.2: Economic Support and Constraint

In contrast, private and non-governmental actors were seen as being bigger supporters of *economic* benefits and goals by respondents. Two respondents believed vendors and EURELCO would actively support economic benefits they hoped to attain, in addition to state and/or provincial agencies. As with *ecological* benefits, the groups considered to be most likely to actively constrain *economic* benefits were the most localized ("municipal / local agencies," "neighborhood / community groups," and "individual residents / citizens"). Developers and private consultants were, somewhat surprisingly, again not considered to be relevant actors to a LFM operation by two of the three respondents.

5.3.5.3: Social Support and Constraint

Overall, this is where respondents felt the fewest number of types of actors were relevant to them attaining *social* goals. The list of suggested answers that received two "not applicable" responses is: private consultants, developers / real estate interests, vendors, EURELCO, and colleagues. In juxtaposition, the only answers that received any "actively support responses" each only got one out of three responses. The actors that were thought to be supportive or neutral were all over the map, with no conclusive opinion.

5.4: Analyzing Landfill Mining Through a Biotechnic Frame

Landfill mining, as demonstrated in the previous two sections, is driven by a variety of benefits and limitations that can combine in both beneficial and detrimental ways. This section will measure landfill mining against the characteristics of a biotechnic frame outlined at the end of Chapter 4.

5.4.1: Summary and Analysis

In order to evaluate whether the practice of landfill mining fits within a biotechnic frame of planning, I will attempt to answer each of the guiding question criteria laid out earlier in section 4.5.2. This analysis is high-level, rather than evaluating a specific case of landfill mining, so for some criterions the answer may be an equivocal yes, rather than a decisive one.

5.4.1.1: Is the Practice Self-Sustaining Over the Long-term?

Not completely. Landfill mining can only be practiced as long as landfills exist, and as long as landfills exist we will have not completely reframed waste into resource. There is a possibility of perpetually landfill mining at a specific site, by rotating through cells using temporary storage; however, as post-consumer material is most valuable prior to landfilling, relying on perpetual landfill mining runs counter to the waste hierarchy's tenets of highest and best use. Finally, specific landfill mining projects might not generate enough positive benefits to outweigh negative externalities, and therefore could require outside infusions of cash to make them economically viable in the near future. Should landfill mining ever become a political priority and gain traction with a wide base of people, it is possible that external support could be secured for LFM projects that do not generate traditional revenue and profits. However, the system may always require this sort of external sustainment. Until more pilot projects have been completed in a variety of contexts, I cannot conclude that LFM is fully self-sustaining.

LFM is self-sustaining in some ways, of course, and especially compared to what we are doing currently by relying on landfills as final sinks. LFM operations return land (and therefore potentially wildlife habitat and recreational opportunities) to use, while landfilling simply takes that land offline without generating nearly as many benefits. Landfilling is still heavily subsidized in some portions of the U.S. with cheap land costs and low population density, yet landfills only provide a singular service (imperfect long-term storage). In contrast, LFM, if added as one of many other biotechnic solid waste management policies has to potential to truly tip the balance in the right direction.

5.4.1.2: Is the Practice Transdisciplinary?

Potentially. The practice of landfill mining has the ability to become transdisciplinary. More than multidisciplinary or interdisciplinary, transdisciplinary collaboration is a “quest for a wider and deeper knowledge of a compound reality”

(Lattanzi 1998, 15). Following Klein (2008), transdisciplinary studies are iterative, with the research team working together to challenge assumptions of each discipline and formulate problems, methods, and conclusions as the result of a dialectic among the disciplines. Landfill mining has the ability to be this kind of practice and mode of study.

LFM expertise will pull from a large variety of academic disciplines (e.g., planning, geology, chemistry, physics, business, public administration, engineering, public health, biology, ecology, economics, etc.). Additionally, outside of traditional academic disciplines, LFM operators will have a variety of technical skillsets (e.g., construction, excavation, forestry, remediation, surveying, data science, etc.). In addition to the numerous areas of expertise that can come to bear on any LFM project, the field's nascence may provide the further benefit of allowing actors to challenge standardly held notions as they move into uncharted territory.

Research teams have already begun to integrate these areas of expertise, and organizations like EURELCO are already working to build a network of actors from public agencies, waste authorities, scientists, researchers, companies, and civic organizations (EURELCO 2017). The challenge will be to fully integrate actors in specific projects. Rather than working parallel to one another within their own area of expertise and periodically "reaching across the aisle," LFM agents will have to work in tandem collaboratively to dismantle the aisle.

5.4.1.3: Does the Practice Encourage Citizen Participation and Expertise?

Not currently. Landfill mining pilot studies and research have not yet chosen to incorporate citizen participation and expertise directly into their practice. I will discuss how LFM can move towards a "yes" answer to this question, but first, a word on inclusive and participatory decision making.

Since the communicative/participatory turn in planning, a focus on "inclusionary decision making" has emerged (Innes and Booher 2010, 92). Innes and Booher (2010) assert that any collaborative rational process "has to engage all those who have pertinent knowledge and a stake in the issue," not solely out of some altruistic ideal but because, pragmatically, a diverse and informed set of views lead to higher quality decision making processes and decisions (93). This model of an inclusive decision making process in which all participants are treated and listened to equally comes from the work of Jurgen Habermas and his theory of communicative action and rationality (1981) and also from John Dewey (1927) and his theory of participatory democracy. The knowledge needed to engage in communicative rationality (and, by extension, pragmatic and participatory planning) is "emancipatory, in that it requires getting past reified power relations and unacknowledged assumptions that distort knowledge" (Innes and Booher 2010, 23). Emancipatory knowledge is formed by and forms the basis of *praxis*, which “involves skills, intuitive knowledge, and tacit theory that come from deep and extended experience” (Innes and Booher 2010, 23).

Landfill mining at this point in time has not engaged with all relevant stakeholders of projects, especially on the individual citizen’s level. This is apparent for three reasons. First, anecdotally, no resident I met during my two weeks in Belgium expressed any familiarity with or knowledge of the LFM operation already underway at the Remo landfill site. While of course my experience and that of the people I met is not constitutive of the experience of all neighbors of Remo, it is telling that even the owner of the nearest café T’Boske (just a mile from Remo) was surprised to hear anything was going on there. Second, nowhere in the existing literature or case studies on landfill mining was the convening of citizens mentioned. That the literature and pilot projects have not yet focused on developing, as Innes and Booher (2010) call them, *communities of inquiry* for LFM suggests that at this time it is not a major concern for those undertaking landfill mining. Third, the preliminary survey data I collected from respondents familiar with landfill mining suggests that individual citizens/residents and neighborhood/community groups are seen as actors that may “actively constrain” LFM processes. This assumption that people who are clearly stakeholders capable of building upon their own localized knowledge and interests are antagonist to LFM places the process squarely into a rationalist frame of planning. To fulfill this criteria of a biotechnic frame, landfill mining scholars and practitioners must move past an expert-only model of planning and accept what Geddes saw as a town planner engaged with both teaching and learning from community members in a praxis-based model.

5.4.1.4: Is the Practice Place-based and Context Specific?

Yes. Landfill mining at its heart must deal with the specific waste characteristics of each site in order to valorize waste and take advantage of additional benefits. LFM operations also consider context-specific regulations, transportation and land costs, and energy markets during project planning in order to attain the highest possible benefits. While land value may be a primary motivator in regions with dense urbanization facing land scarcity, other regions with highly developed secondary materials markets may more heavily lean on the resource mining potential of landfills in their operations. As previously discussed, areas heavily reliant on fossil fuels will see greater benefits in climate change mitigations with landfill mining than those areas already powered by primarily renewable energy sources. LFM has also been shown to be more profitable when remanufacturers and recyclers are nearby, and thus it supports a place-based circular economy.

5.4.1.5: Are there Built-in Feedback Loops to Adapt Practice Over Time?

Potentially. Feedback loops allow for “self-correction” in a system “and adjusts its operation according to differences between the actual and the desired or optimal output” (American Heritage Dictionary of the English Language 2016). Rapid updating of information, which is in turn fed back in order to adapt the system, can increase system performance and resiliency. While feedback loops in LFM operation are not explicitly addressed in the literature, as technology advances and more pilot projects begin, it is likely that a robust sharing information network could establish feedback loops between practitioners.

Among researchers, feedback loops and adaptation go hand in hand with the reformulation of assumptions. Reflexive modernity, a tenet of STS studies, argues that, for example rather than asking if a practice is safe, we ought to instead ask “how safety is proven” (Yearly 2013, 937). These types of higher level questions of assumptions and methods are already taking place in landfill mining studies. Several researchers have attempted to describe an appropriate framework for evaluating the positives and negatives in landfill mining holistically, working to determine the right types of decision making tools and accounting methods to use for the practice. For example, Herman, et al. (2014) have questioned the spatial and temporal boundaries that frame landfill mining. Because “no standardized assessment tools exist,” the authors suggest more work needs to be done on defining those boundaries in order to create corresponding tools for holistic analysis (Herman, et al. 2014, 56). They recommend validity checks “based on real data” to “obtain usable results” to drive “further research needs” (Herman, et al. 2014, 56).

5.4.1.6: Does the Practice Value Life Above Everything Else?

No. Landfill mining cannot be said to place the highest value on life and life systems at this time, nor is it likely to as a whole do so in the future. Profit streams are still the primary concern and motivating factor in undertaking LFM operations today. Since the renewed interest of the last five years in landfill mining as more than a process of topsoil reclamation, most literature and pilot projects have attempted to characterize waste and valorize it in terms of monetary benefits. Even those frameworks that evaluate landfill mining through ecological and social factors in addition to economic ones seek ways to quantify ecological and social benefits in dollar amounts rather than in number of lives enriched, degree of circularity in the urban metabolism, or some other non-monetary unit.

This is not to say that landfill mining is a worthless pursuit, or that it could not meet this criteria in certain cases. Specifically, I can imagine LFM projects whose primary goal is hazardous site remediation placing the value of health, safety, and life above any considerations of monetary profits and losses. Further, even when landfill mining is practiced with economic goals in mind, the resulting benefits to the ecosystem and urban metabolism can still be positive. Finally, when compared to alternatives such as continuing to landfill waste or capping a landfill without any excavation, the process of landfill mining can be seen as the clear winner on this criterion.

5.4.2: Summary: Does Landfill Mining "Fit" Within a Biotechnic Frame?

After evaluating landfill mining in light of the characteristics of Geddesian biotechnics, it is clear that the practice is not fully biotechnic. I am unable to answer all of the criteria questions with an emphatic "yes." The results are, instead, mixed. Landfill mining *is* inherently place-based and context specific, and it has the potential both to become transdisciplinary and to incorporate feedback loops as it matures as a sociotechnological system. However, the practice is not completely self-sustaining, and LFM does not currently encourage citizen participation and expertise. Both of those characteristics are necessary steps for landfill mining to become biotechnic, though by themselves they are insufficient. Above everything else, the most important characteristic, whether landfill mining values life above everything else, is not met. LFM is not, therefore, an example of Geddesian biotechnics and biocivics. From this analysis, I would instead preliminarily characterize landfill mining as a geotechnic/geocivic practice when it holistically considers ecological, economic, and social benefits, and a neotechnic practice when it only focuses on attaining economic benefits.

That is not to say, however, that simply because landfill mining is not biotechnic it does not fit within a biotechnic frame of planning. After all, biotechnics and biocivics are “cardinal ideals,” “unattainable directions” that “enable us to measure and to criticise the city of the present, and to make provision for its betterment, its essential renewal” (Geddes 1915, 87). Practices that are neotechnic and geotechnic move use closer to *eu-topia*, by which Geddes meant something very different from *ou-topia*. Eutopia is a “practicable alternative” and “possible in the given city,” which is “a very different thing from a vague *Ou-topia*, concretely realizable nowhere” (Geddes 1906, 117). While a biotechnic society may not be a fully achievable in the form of a utopia, every practice that takes us further from a paleotechnic society and closer towards a biotechnic society can be said to be actively building eutopia. Therefore, projects that are neotechnic and geotechnic fit within a biotechnic frame of planning that seeks to build eutopia.

CHAPTER 6: CONCLUSIONS

I asked three questions at the beginning of this research project:

Q1) What frames has the field of planning employed in MSW management?
Q2) Are there unintended consequences to the frames previously utilized that have contributed to our current MSW problem?
Q3) Can Geddes' biotechnic approach to planning provide an effective alternative frame for MSW management?

To answer the first research question, I drew on historical and theoretical methods to examine frames, or modes of understanding, in solid waste management using Goffman's (1986) construction. I found evidence supporting three distinct frames of planning for solid waste, the *radical positivist*, the *grassroots communitarian*, and the *insurgent radical*. Each frame has different constructions of both problem and solution, responses to authority and technology, and beliefs about the nature of decision making. I have included these characteristics again, this time alongside the guiding questions that a biotechnic frame asks in Table 2.

TABLE 2: HISTORIC MSW MANAGEMENT FRAMES VS. A BIOTECHNIC FRAME

	Rational Positivist	**Grassroots Communitarian**	**Insurgent Radical**
Definition of problems	Problems are discreet and planners can address problems in insolation from one another	Problems are linked and these linkages should be understood	Problems are completely intertwined with one another and cannot be separated
Definition of solutions	The "right" solution can be found	There are "right" solutions that together can be found	Rather than looking for the "right" solution, we should try everything that has positive impacts
Attitude towards intervention	Technology advances will be the answer to our problems	Coalition building will be the answer to our problems	Solidarity and social justice will be the answer to our problems
Attitude towards context	What works for one city will likely work for all cities	We can apply aspects of what works for one city to another	What works for one city might not work for another city
Attitude towards decision making	The state has a responsibility to address urban problems, and therefore state-sponsored planners are the experts who should make decisions	Citizens have a responsibility to address urban problems, and therefore community members should work with authorities to make decisions	Citizens have a responsibility to address urban problems, and therefore community members are the experts who should make decisions
Biotechnic Frame			
Is the Practice Self-Sustaining Over the Long-term?			
Is the Practice Transdisciplinary?			
Does the Practice Encourage Citizen Participation and Expertise?			
Is the Practice Place-based and Context Specific?			
Are there Built-in Feedback Loops to Adapt the Practice Over Time?			
Does the Practice Value Life Above Everything Else?			

To answer the second research question, I traced consequences of rational positivist, grassroots communitarian, and insurgent radical frames to both positive and negative contributions to our current solid waste situation, where waste is considered primarily as either a *nuisance* or a *hazard*, but rarely as a *resource*. "Solutions" to waste management that did not take into account the lessons, summarized in Table 3, were shown to be less successful and have greater negative consequences.

TABLE 3: LESSONS LEARNED FROM THE HISTORY OF U.S. WASTE MANAGEMENT

Theme	Lesson
Urban Dynamism	Cities are in complex adaptive systems that require iterative interventions rather than magic bullet solutions
Incremental Technological Change	Technological advances slowly drive system boundary expansion and results in friction between sub-systems
Context-Dependency	Like resilient ecosystems, sustainable sociotechnological systems are context dependent and responsive
Sociological Costs of Professionalization	Professionalization results in frame lock-in and can work at cross purposes with the public good
Causes of Frame Shifts	Frame shifts are caused when an accumulation of anomalies can no longer be ignored
Nature of Neoliberalism	Neoliberal economies mask harmful deregulation and externalization of negative effects with rhetoric of "freedom to choose" and individual responsibility
Benefits of Triage	Triage can help address both the most pressing acute symptoms of the metabolic rift and the chronic underlying conditions that create it

Following Patrick Geddes' theory of technics and civics, I defined characteristics of a *biotechnic* frame and drew comparisons between several current analogs in solid waste today, including the zero-waste movement, urban metabolism studies, and circular economy studies. To answer the third research question, I analyzed landfill mining through the characteristics of a biotechnic frame. The findings of my analysis are recorded in Table 4.

TABLE 4: FINDINGS: BIOTECHNIC ANALYSIS OF LANDFILL MINING

Biotechnic Analysis of Landfill Mining	Conclusion
Is the Practice Self-Sustaining Over the Long-term?	Not completely
Is the Practice Transdisciplinary?	Potentially
Does the Practice Encourage Citizen Participation and Expertise?	Not currently
Is the Practice Place-based and Context Specific?	Yes
Are there Built-in Feedback Loops to Adapt the Practice Over Time?	Potentially
Does the Practice Value Life Above Everything Else?	No

In response, I found that landfill mining, though having the potential to become biotechnic, is currently a practice closer to Geddes' *neotechnic* or *geotechnic* categories. Landfill mining, if it can apply the lessons learned from U.S. solid waste management history, will be well-equipped to develop into a biotechnic practice, and, indeed, scholars such as Johansson (2016) have begun through their research to make the case for a reframing of waste into resource.

6.1: The Case for a Biotechnic Frame

The metabolic rift of our cities is quickly becoming known to researchers and planners. From its early beginnings in Marx's *Capital*, to contemporary solid waste management trends that incorporate it into their study (e.g., the zero-waste movement, urban metabolism studies, and circular economy studies), metabolic rift is a useful construction with which we can better understand urbanization issues today. Though not often referenced by each of its contemporary analogs, Patrick Geddes' biotechnic frame is present within each of these complementary trends. The biotechnic frame is a blend of previous waste management frames, with Law (2005) calling Geddes a "pragmatic radical" (sec. 9.2).

My research synthesizes the zero-waste movement, urban metabolism studies, and circular economy studies underneath a common biotechnic frame for *praxis*, or a mutually reinforcing relationship of practice and theory (Snyder 1995). The biotechnic mantra of life over all else is uniquely suited to aid planners in their work to balance the urban metabolism and repair its rift. As evidence for the need for a biotechnic frame, I would like to briefly offer another example of an area of solid waste management that is rapidly developing in which such a frame would be indispensable moving forward.

6.1.1: The Need for a Biotechnic Frame: The Case of "Smart" Technologies

With the spread of "smart technologies" throughout U.S. cities, there is a new layer of information and communication (ICT) infrastructure being introduced that planners are only beginning to come to terms with. The possibilities of smart technologies are seemingly endless, from smart dumpsters that alert haulers immediately when full, to smart trucks that record the addresses of residents who fail to separate trash from recycling, to smart landfills that track much better the "what" and "where" of disposal. Each of these have the potential to revolutionize solid waste management, but each also have the potential to become paleo, neo, geo, or biotechnic practices.

Take, for example, the case of smart hauling trucks. Currently, waste haulers (private, public, or contracted) visit homes and businesses on set days in set routes, picking up cans, bins, and dumpsters whether they are a quarter or completely full. By contrast, a system of smart dumpsters and trucks could "optimize garbage collection" by alerting haulers when a bin is full, managing the routes those haulers take to reduce overall vehicle miles traveled and emissions, and over time develop a spatially optimized strategy for bin location based on tracked data (Borozdukhin, et al. 2016, 918).

The technological component on its own, however, as we have seen in Geddes' theory of technics and civics, will not tell us what kind of practice smart collection will be (i.e., paleo, neo, geo, or biotechnic). Will the ability to have haulers on call turn an industry that has historically been unionized with employment certainty high, instead into a system of independent contractors with low employment certainty? Will, as Chen, et al. (2016) hint at, areas of cities with low densities "be less significant" and therefore less frequently serviced (5)? Or, as history has shown, will low-income and minority communities be less frequently serviced by these haulers or the assumptions of algorithmic route optimization? These questions of the socio, or civic, component of smart technologies, cannot be answered using strictly the rational positivist, grassroots communitarian, or insurgent radical frames that I developed in chapter 3. A biotechnic frame is not only useful, but essential for planners grappling with new technologies and their corresponding sociological practices. Performing a similar biotechnic analysis of smart collection technologies is an important way in which my research might be extended in the future.

6.2: Next Steps and Final Thoughts

I still feel strongly at the conclusion of this revised research agenda that my original research agenda is a necessary and important set of questions that must be answered for landfill mining to spread. Information networks and resource types will likely only continue to become more complex and dynamic in the remainder of the twenty-first century. It is in analysis of a sociotechnological system's diffusion where we can look to the work of Everett Rogers (1962) on the "diffusion of innovations" and other communication theories more closely. Studying the diffusion of innovation process for different paleo, neo, geo, and biotechnic practices will help planners better understand ways in which they can intervene at strategic leverage points in order to foster the biotechnic frame. Sustainable solid waste innovations are "preventative," a special case of technological innovation according to Rogers (2002), in which "an individual has to adopt a new idea at a certain time in order to avoid the likely occurrence of some unwanted event at a later date" (335). The sooner planners are able to define the characteristics of biotechnic innovation adoption and diffusion, the sooner such research can be applied to balancing our urban metabolisms.

Our current solid waste system is fractured and we have worked ourselves into an untenably precarious situation in regard to public health, economic development, and social equity by relying on planning frames that believe waste can be sent "away" in landfills and incinerators. Knowing this, however, I am still optimistic and personally excited for what I see as the challenge of my coming planning career: reframing waste through a reflective biotechnic and biocivic practice. Each shift of frame in solid waste planning so far has come at just such as tumultuous time as we find ourselves in now, when the “anomalies” and negative impacts of a paradigm no longer can be explained away.

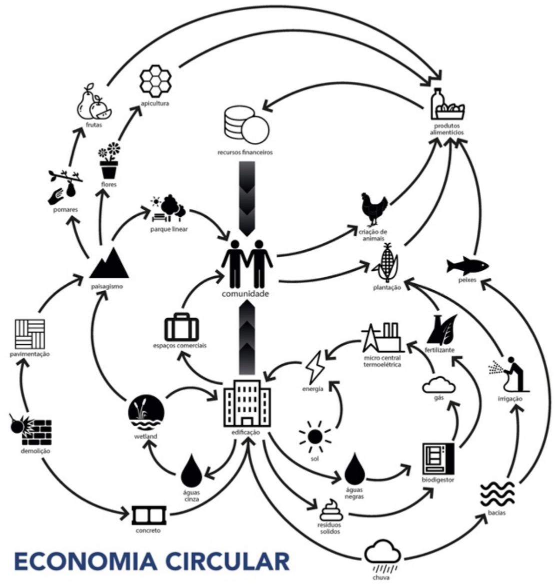
I would like to close this project with a call to a “militant peace,” “founded upon a survey of facts, organized, active, vivid, vigilant, resourceful, strenuous and militant as wardom itself” (Geddes and Slater 1917, 56). As Geddes (1915) saw it, the conditions for such a biotechnic peace are never far away.

> “People volunteer for war; and it is a strange and a dark superstition that they will not volunteer for peace. On the contrary, every civic worker knows that, with a little judicious inquiry and management, any opportunity which can be found for public service is not very long of being accepted, if only the leadership for it can be given: that is still scarce, but grows with exercise and service” (101).

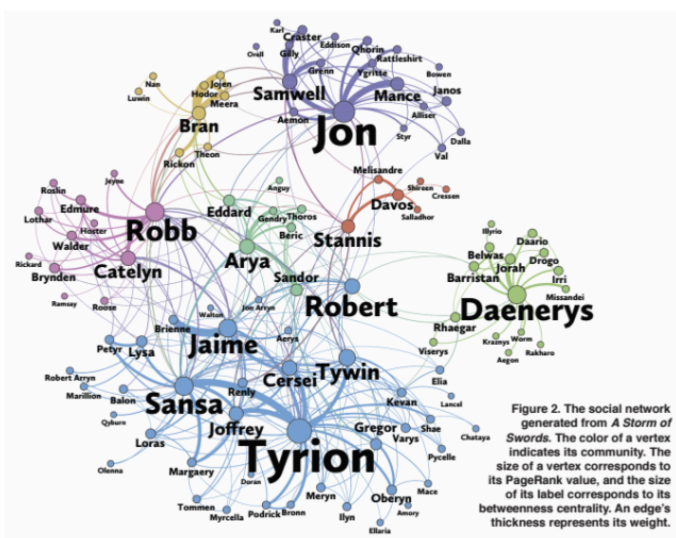
Let us each use practice leadership as planners through exercise and service, and “volunteer for peace.”

Appendices

Appendix A: Examples of Actor-Network Diagram

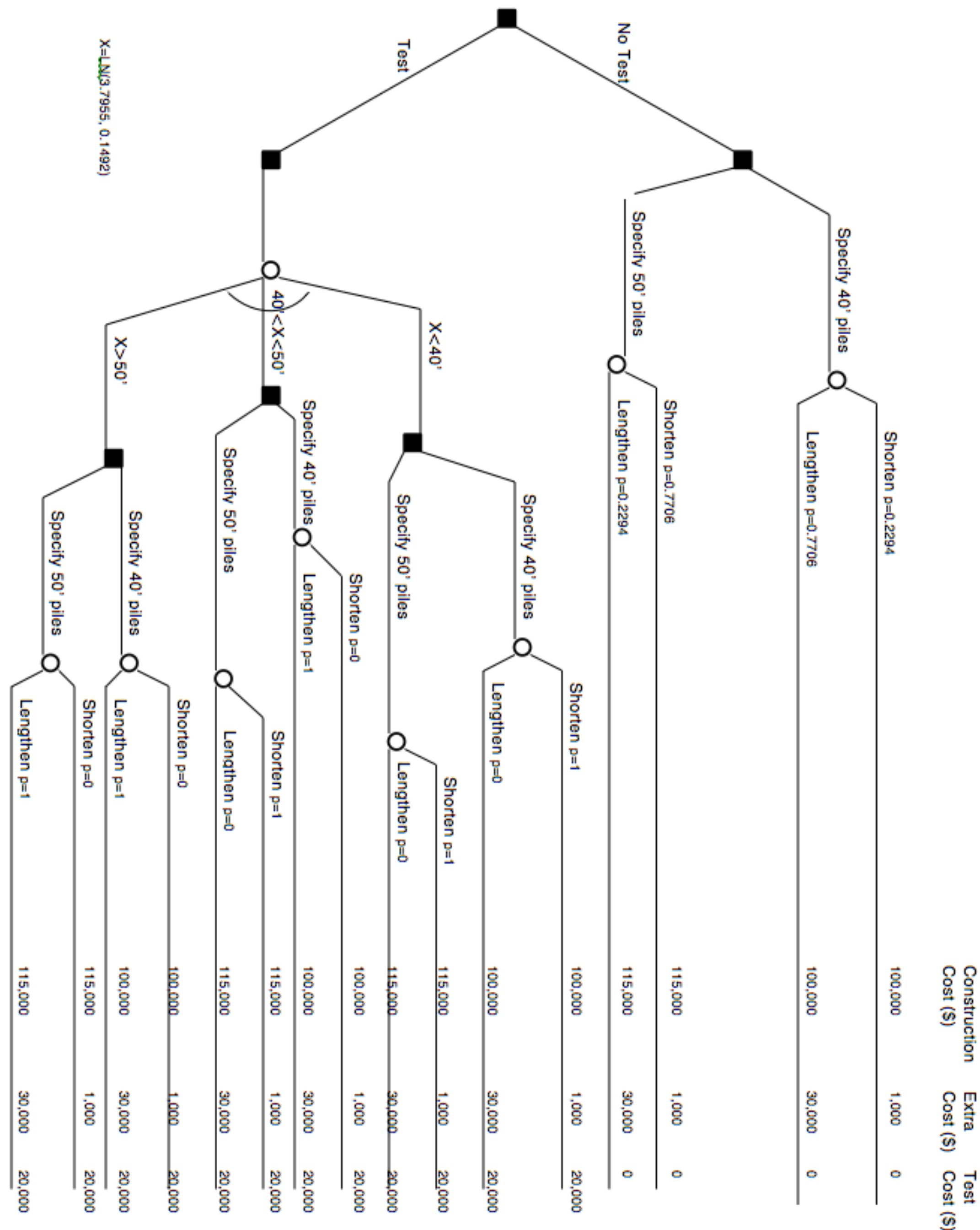


(source: Federal University of Paraná "Pensar la Vivenda, Vivir la Ciudad" contest team)



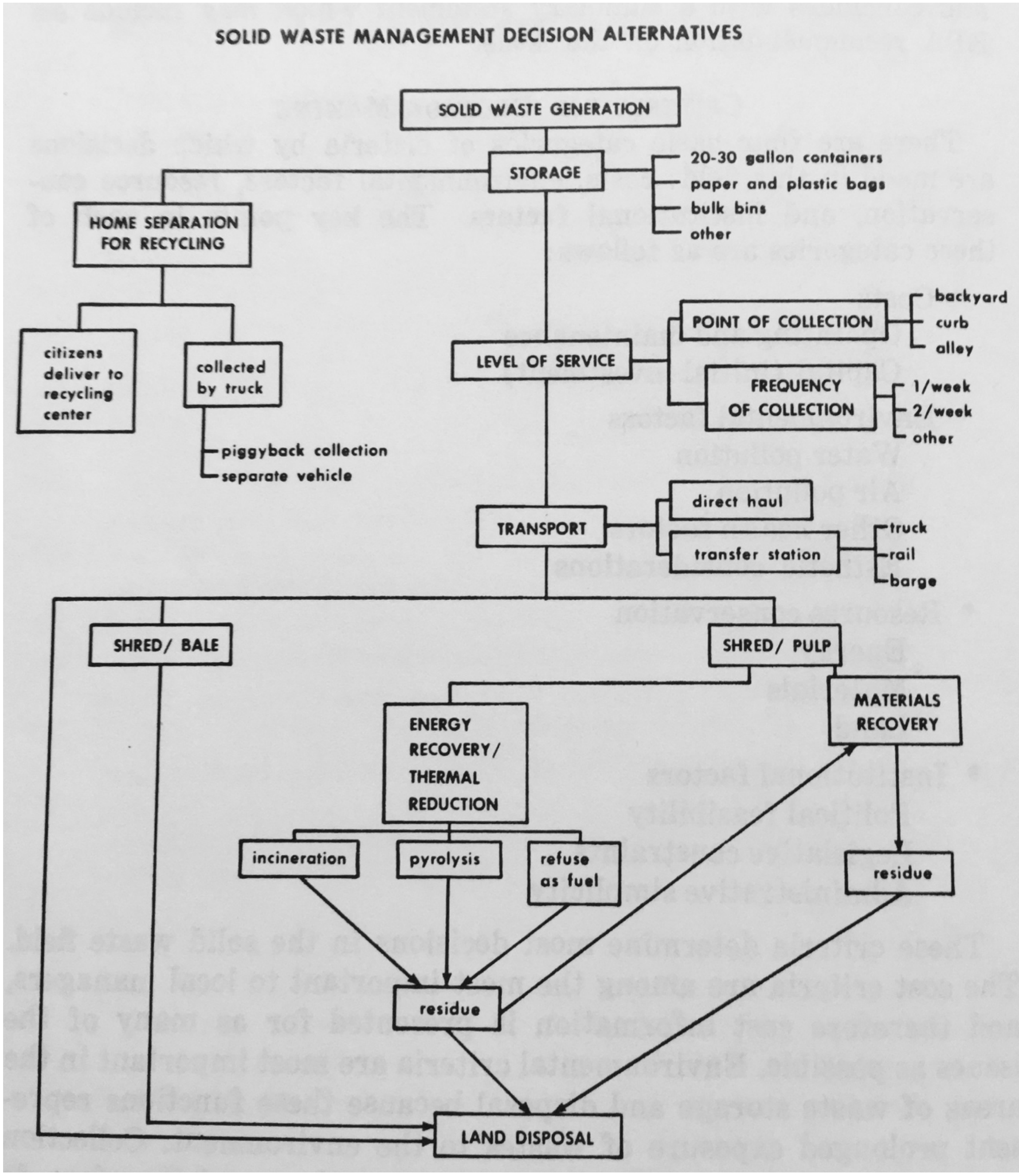
(source: "Network of Thrones," Beveridge and Shan (2016))

Appendix B: Example of Decision-Tree Analysis Model



(source: author)

Appendix C: 1974 EPA Flowchart for Solid Waste Management Decisions



(source: Colonna and McLaren (1974))

References

Adams, Jennifer. "Popular Green Culture." In *Green Culture: An A-to-Z Guide*. Edited by Kevin Wehr. Thousand Oaks, CA: SAGE, 2011. 719-726.

Addams, Jane. *Twenty Years at Hull-House (with Autobiographical Notes)*. New York: Macmillan, 1940 [1910].

Albert, Richard C. "The Historical Context of Water Quality Management for the Delaware Estuary." *Estuaries and Coasts* 11, no. 2 (1988): 99-107.

Alexander, Catherine. "When Waste Disappears, or More Waste Please!" In *Out of Sight, Out of Mind: The Politics and Culture of Waste*. Edited by Christof Mauch. *RCC Perspectives: Transformations in Environment and Society* 1 (2016): 31-39.

Alexander, Judd. *In Defense of Garbage*. Westport, CT: Praeger Publishers, 1993.

American Heritage Dictionary of the English Language. "Feedback Loop." In *American Heritage Dictionary of the English Language*, 5th ed. Boston: Houghton Mifflin Harcourt, 2016.

American Institute of Certified Planners. "AICP Code of Ethics and Professional Conduct." *American Planning Association* (website). Revised 2016. Accessed at https://www.planning.org/ethics/ethicscode/.

Architecture 2030. "Why the Building Sector?" *Architecture 2030* (website). 2017. Accessed at http://architecture2030.org/buildings_problem_why/.

Austin Resource Recovery. *Austin Resource Recovery Master Plan* (government report). City of Austin, December 15, 2011.

Austin Water. "Center for Environmental Research." *Austin Water* (website). N.d. Accessed at http://www.austintexas.gov/cer.

Baas, Leenard, Joakim Krook, Mats Eklund, and Niclas Svensson. "Industrial Ecology Looks at Landfills from Another Perspective." *Regional Development Dialogue* 31, no. 2 (2010): 169-183.

Bandow, Doug. “Radical Activism Cannot Help Protect the Environment.” In *The Environmental Crises: Opposing Viewpoints*. Edited by Neal Bernards. San Diego, CA: Greenhaven Press, 1991. 254-260.

Barnard, Alan. “Structuralism.” In *International Encyclopedia of the Social Sciences* 8, 2nd ed. Edited by William A. Darity, Jr. Detroit: Macmillan Reference USA, 2008. 181-183.

Bartlett Crane, Caroline. “The Work for Clean Streets.” In *New York City Women’s Municipal League Bulletin* 5 (1906): 1.

Bell, Derek. “Environmental Justice and Rawls’ Difference Principle.” *Environmental Ethics* 26, no. 3 (2004): 287-306.

Blumberg, Louis and Robert Gottlieb. *War on Waste: Can America Win Its Battle with Garbage?* Washington, D.C.: Island Press, 1989.

Boardman, Philip. *Patrick Geddes: Maker of the Future*. Introduced by Lewis Mumford. Chapel Hill, NC: University of North Carolina Press, 1944.

Bogner, Jean E., Kurt Spokas, Elizabeth Burton, R. Sweeney, and V. Corona. “Landfills as Atmospheric Methane Sources and Sinks.” *Chemosphere* 31, no. 9 (1995): 4119-4130.

Borozdukhin, Andrei, Olga Dolinina, and Vitaly Pechenkin, "Approach to the Garbage Collection in the ‘Smart Clean City’ Project." *4th IEEE International Colloquium on Information Science and Technology*. Tangier, 2016. 918-922.

Boslaugh, Sarah. “Technological Momentum.” In *Green Technology: An A-to-Z Guide*. Edited by Dustin Mulvaney. Thousand Oaks, CA: SAGE, 2011. 406-408.

Bosmans, Anouk, Ive Vanderreydt, Daneel Geysen, and Lieve Helsen. “The Crucial Role of Waste-to-Energy Technologies in Enhanced Landfill Mining: A Technology Review.” *Journal of Cleaner Production* 55 (2013): 10-23.

Braungart, Michael and William McDonough. *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press, 2002.

Brewer, Paul R. "Framing, Value Words, and Citizens' Explanations of Their Issue Opinions." *Political Communication* 19, no. 3 (2002): 303-316.

Brunner, Paul H. "Reshaping Urban Metabolism." *Journal of Industrial Ecology* 11, no. 2 (2007): 11-13.

Burrows, Edwin G. and Mike Wallace. *Gotham: A History of New York City to 1898*. New York: Oxford University Press, 1999.

Carless, Jennifer. *Taking Out the Trash: A No-Nonsense Guide to Recycling*. Washington, D.C.: Island Press, 1992.

Carrington, Damian. "Pollution Risk from Over 1,000 Old UK Landfill Sites Due to Coastal Erosion." *The Guardian*, May 5, 2016.Accessed at https://www.theguardian.com/environment/2016/may/05/pollution-risk-from-over-1000-landfill-sites-england-wales-coastal-erosion.

Carson, Mina. *Settlement Folk: Social Thought and the American Settlement Movement, 1885—1930*. Chicago: University of Chicago Press, 1990.

Carson, Rachel. *Silent Spring*. Boston: Houghton Mifflin, 1962.

Center for Environmental Research. "Hornsby Bend Biosolids Management Plant: Protecting Austin's Environment through Urban Waste Recycling, Environmental Research, and Education." *Austin Water* (government report), N.d.

Chadwick, Edwin. *Report on the Sanitary Condition of the Labouring Population and on the Means of its Improvement*. London, 1842.

Chapin, Charles V. "Profit from Garbage." In *American Journal of Public Health* 1, (1911): 288.

Chen, Yin, Jin Nakazawa, Takuro Yonezawa, Takafumi Kawasaki and Hideyuki Tokuda. "An Empirical Study on Coverage-Ensured Automotive Sensing Using Door-to-Door Garbage Collecting Trucks." *SmartCities '16: Proceedings of the 2nd International Workshop on Smart Cities*. Trento, Italy, Dec. 12-16, 2016.

Chicago Tribune. “Underground Fire Outside St. Louis has Burned Since 2010, Nears Nuclear Waste Dump.” *Chicago Tribune*, October 15, 2015.

Colonna, Robert A. and Cynthia McLaren. “Decision-Makers Guide in Solid Waste Management.” *United States Environmental Protection Agency: Office of Solid Waste Management Programs*. Washington, D.C.: U.S. Government Printing Office, 1974.

Corburn, Jason. *Toward the Healthy City: People, Places, and the Politics of Urban Planning*. Cambridge, MA: MIT Press, 2009.

Crocker, Robert and Steffen Lehmann. “Conclusion.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. New York: Earthscan, 2012.

Cross, Gary. *An All-Consuming Century: Why Commercialism Won in Modern America*. New York: Columbia University Press, 2000.

Damigos, Dimitris, Maria Menegaki, and Dimitris Kaliampakos. “Monetizing the Social Benefits of Landfill Mining: Evidence from a Contingent Valuation Survey in a Rural Area in Greece.” *Waste Management* 51 (2016): 119-129.

Danthurebandara, Maheshi, Steven Van Passel, Ive Vanderreydt, and Karel Van Acker. “Assessment of Environmental and Economic Feasibility of Enhanced Landfill Mining.” *Waste Management* 45 (2015): 434-447.

Devall, Bill. “Radical Activism Can Help Protect the Environment.” In *The Environmental Crises: Opposing Viewpoints*. Edited by Neal Bernards. San Diego, CA: Greenhaven Press, 1991. 246-253.

Dewey, John. *The Public and Its Problems*. Chicago: Swallow Press, 1954 [1927].

Dickson, Eyoh. “Modernization.” In *New Dictionary of the History of Ideas* Vol. 4. Edited by Maryanne Cline Horowitz. Detroit: Charles Scribner's Sons, 2005. 1485-1487.

Engels, Friedrich. *The Conditions of the Working Class in England in 1844*. Translated by Florence Kelley Wischnewetzky. New York: John W. Lovell Co., 1887.

Environmental Protection Agency. *Characterization of Municipal Solid Waste in the United States: 1995 Update*. 1995. Accessed at http://infohouse.p2ric.org/ref/02/01837/msw95.pdf.

———. *Landfill Reclamation*. EPA530-F-97-001, July 1997.

———. *Advancing Sustainable Materials Management: 2014 Fact Sheet Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery and Landfilling in the United States*. November 2016. Accessed at https://www.epa.gov/sites/production/files/2016-11/documents/2014_smmfactsheet_508.pdf.

———. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2015*. 2017.

———. "Superfund History." *United States Environmental Protection Agency* (website). N.d. Accessed at https://www.epa.gov/superfund/superfund-history.

Environmental Protection Agency, Region 5. "Illegal Dumping Prevention Guidebook." *United States Environmental Protection Agency*. March 1998. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=2000CNVU.txt.

Ehrlich, Paul R. *The Population Bomb*. New York: Ballantine Books, 1968.

EURELCO. "Definition." *European Enhanced Landfill Mining Consortium* (website), 2017. Accessed at https://www.eurelco.org/definition.

Fainstein, Susan S. and Scott Campbell. "Introduction: The Structure and Debates of Planning Theory." In *Readings in Planning Theory* 3rd ed. Edited by Susan S. Fainstein and Scott Campbell. Malden, MA: Wiley-Blackwell, 2012. 1-20.

Fainstein, Susan S. and Lisa J. Servon. *Gender and Planning: A Reader*. New Brunswick, NJ: Rutgers University Press, 2005.

Feenberg, Andrew. “Incommensurable Paradigms: Values and the Environment.” In *Pragmatic Sustainability: Dispositions for Critical Adaptation* 2nd ed. Edited by Steven A. Moore. New York: Routledge, 2016. 275-288.

Finer, S. E. *The Life and Times of Sir Edwin Chadwick*. London: Methuen, 1952.

Fisher, Richard. “Key Issue Paper: Landfill Mining.” *International Solid Waste Association* (2013): 1-7.

"Florence Nightingale." In *World of Health*. Gale: Science in Context, 2006.

Forester, John. *Planning in the Face of Power*. Berkeley, CA: University of California Press, 1989.

Foster, John Bellamy. “Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology.” *American Journal of Sociology* 105, no. 2. September 1999, 366-405.

———. *Marx’s Ecology: Materialism and Nature*. New York: Monthly Review Press, 2000.

Frändegård, Per, Joakim Krook, and Niclas Svensson. “Integrating Remediation and Resource Recovery: On the Economic Conditions of Landfill Mining.” *Waste Management* 42 (2015): 137-147.

Frändegård, Per, Joakim Krook, Niclas Svensson, and Mats Eklund. “A Novel Approach for Environmental Evaluation of Landfill Mining.” *Journal of Cleaner Production* 55 (2013a): 24-34.

———. “Resource and Climate Implications of Landfill Mining: A Case Study of Sweden.” *Journal of Industrial Ecology* 17, no. 5 (2013b): 742-755.

Franklin Associates, Ltd. *The Role of Recycling in Integrated Solid Waste Management to the Year 2000*. Stamford, CT, 1994.

Geddes, Patrick. *John Ruskin: Economist*. Edinburgh: Brown, 1885. Reprinted as “John Ruskin, as Economist.” *International Monthly* 1 (1900): 280-308.

———. *Civics: As Applied Sociology*. Urbana, IL: Project Gutenberg, 2004 [1906].

———. “The Twofold Aspect of the Industrial Age: Paleotechnic and Neotechnic.” In *Town Planning Review* 3, (1912): 176-187.

———. *Cities in Evolution: An Introduction to the Town Planning Movement and to the Study of Civics*. London: Williams & Norgate, 1915.

Geddes, Patrick and Gilbert Slater. *The Making of the Future: Ideas at War*. London: Williams and Norgate, 1917.

Geddes, Patrick and Victor Branford. *The Making of the Future: Our Social Inheritance*. London: Williams and Norgate, 1917.

Geysen, Daneel. “Implementation of Temporary Storage at the Remo Landfill Site.” *2nd International Academic Symposium on Enhanced Landfill Mining* (presentation), Houthalen-Helchteren, Belgium, October 14-16, 2013.

Gilding, Paul. *The Great Disruption: Why the Climate Crisis Will Bring on the End of Shopping and the Birth of a New World*. New York, NY: Bloomsbury Press, 2011.

Goffman, Erving. *Frame Analysis*. Boston: Northeastern University Press, 1986.

Gottlieb, Robert. *Forcing the Spring: The Transformations of the American Environmental Movement*. Washington, D.C.: Island Press, 1993.

Graves, William. “Core-Periphery Models.” In *Encyclopedia of Human Geography*. Edited by Barney Wharf. Thousand Oaks, CA: SAGE, 2006. 62.

Greedy, Derek. “Editorial: Landfilling and Landfill Mining.” *Waste Management & Research* 34, no. 1 (2016): 1-2.

Griscom, John H. *The Sanitary Condition of the Laboring Population of New York, with Suggestions for Its Improvement*. New York: Harper & Brothers, 1845.

Groat, Linda and David Wang. *Architectural Research Methods* 2nd ed. Hoboken, NJ: Wiley, 2013.

Grosse, François. “La Croissance Quasi Circulaire: Une Approche Pragmatique de la Gestion Durable des Ressources Materielles Non Renouvelables.” *Futuribles* 403. (2014): 59-72.

Groth, Paul. “Frameworks for Cultural Landscape Study.” In *Understanding Ordinary Landscapes*. Edited by Paul Groth and Todd W. Bressi. New Haven: Yale University Press, 1997.

Gusca, Julija, Maksims Fainzilbergs, and Indra Muizniece. “Life Cycle Assessment of Landfill Mining Project.” *Energy Procedia* 72 (2015): 322-328.

Habermas, Jurgen. *The Theory of Communicative Action: Reason and the Rationalization of Society*. Boston: Beacon Press, 1981.

Hanks, Reuel R. “Core and Periphery.” In *Encyclopedia of Geography Terms, Themes, and Concepts*. Santa Barbara, CA: ABC-CLIO, 2011. 72-74.

Harvey, David. *Justice, Nature, and the Geography of Difference*. Cambridge, MA: Blackwell Publishers, 1996.

———. *Spaces of Hope*. Edinburgh: Edinburgh University Press, 2000.

———. *Spaces of Global Capitalism: Towards a Theory of Uneven Geographical Development*. New York: Verso, 2006.

———. *Rebel Cities: From the Right to the City to the Urban Revolution*. New York: Verso, 2012.

Healey, Patsy. “Traditions of Planning Thought.” In *Readings in Planning Theory* 3rd ed. Edited by Susan S. Fainstein and Scott Campbell. Malden, MA: Wiley-Blackwell, 2012. 214-233.

Heidegger, Martin. “The Question Concerning Technology.” *The Question Concerning Technology and Other Essays*. Translated by William Lovitt. New York: Harper & Row Publishers, 1977.

Hermann, Robert, Rupert J. Baumgartner, Renato Sarc, Arne Ragossnig, Tanja Wolfsberger, Martin Eisenberger, Andreas Budischowsky, and Roland Pomberger. “Landfill Mining in Austria: Foundations for an Integrated Ecological and Economic Assessment.” *Waste Management & Research* 32, no. 9 (2014): 48-58.

Hermann, Robert, Rupert J. Baumgartner, Stefan Vorbach, Arne Ragossnig, and Roland Pomberger. “Evaluation and Selection of Decision-Making Methods to Assess Landfill Mining Projects.” *Waste Management & Research* 33, no. 9 (2015): 822-832.

Hermann, Robert, Rupert J. Baumgartner, Stefan Vorbach, Tanja Wolfsberger, Arne Ragossnig, and Roland Pomberger. “Holistic Assessment of a Landfill Mining Pilot Project in Austria: Methodology and Application.” *Waste Management & Research* 34, no. 7 (2016): 646-657.

Hogland, William, Marcia Marques, and Sven Nimmermark. “Landfill Mining and Waste Characterization: A Strategy for Remediation of Contaminated Areas.” *Journal of Material Cycles and Waste Management* 6 (2004): 119–124.

Holston, James. “Spaces of Insurgent Citizenship.” In *Making the Invisible Visible: A Multicultural Planning History*. Edited by Leonie Sandercock. Berkeley, CA: University of California Press, 1998.

Howland, Marie. “Employment Effects of Brownfield Redevelopment: What Do We Know from the Literature?” *Journal of Planning Literature* 22, no. 2 (2007): 91-107.

Hughes, Thomas P. “Technological Momentum.” In *Does Technology Drive History? The Dilemma of Technological Determinism*. Edited by Merritt Roe Smith and Leo Marx. Cambridge, MA: MIT Press, 1994. 101-115.

Innes, Judith E. and David E. Booher. *Planning with Complexity: An Introduction to Collaborative Rationality for Public Policy*. New York: Routledge, 2010.

Jacobs, Jane. *The Death and Life of Great American Cities*. New York: Random House, 1961.

James, William. *Pragmatism: A New Name for Some Old Ways of Thinking*. New York: Longmans, Green, and Co., 1907.

Johansson, Nils. “Landfill Mining: Institutional Challenges for the Implementation of Resource Extraction from Waste Deposits.” PhD diss. Linköping University, 2016.

Johansson, Nils, Joakim Krook, and Mats Eklund. “The Institutional Capacity for a Resource Transition: A Critical Review of Swedish Governmental Commissions on Landfill Mining.” *Environmental Science & Policy* 70 (2017): 46-53.

Jones, Peter Tom, Daneel Geysen, Yves Tielemans, Steven Van Passel, Yiannis Pontikes, Bart Blanpain, Mieke Quaghebeur, and Nanne Hoekstra. “Enhanced Landfill Mining in View of Multiple Resource Recovery: A Critical Review.” *Journal of Cleaner Production* 55 (2013): 45-55.

Joseph, Kurian, S. Esakku, and R. Nagendran, “Mining Compost from Dumpsites and Bioreactor Landfills.” *International Journal of Environmental Technology and Management* 7 (2007): 317–325.

Kapur, Amit. “The Future of the Red Metal: Discards, Energy, Water, Residues, and Depletion.” *Progress in Industrial Ecology* 3, no. 3 (2006): 209-236.

Kasun, Jacqueline. *The War Against Population: The Economics and Ideology of World Population Control*. San Francisco: Ignatius Press, 1988.

Katz, Jane. “What a Waste.” In *Federal Reserve Bank of Boston Regional Review* 12, Q1, 2002.

Keller, Suzanne. *Beyond the Ruling Class: Strategic Elites in Modern Society*. New York: Random House, 1963.

Kennedy, Christopher, John Cuddihy, and Joshua Engel-Yan. “The Changing Metabolism of Cities.” *Journal of Industrial Ecology* 11 (2007): 43-59.

Kennedy, Christopher, Stephanie Pincetl, and Paul Bunje. "The Study of Urban Metabolism and its Applications to Urban Planning and Design." *Environmental Pollution* 159, no. 8 (2011): 1965-1973.

Keynes, John Maynard. Quoted in “The First Annual Report of the Arts Council of Great Britain: 1945.” *The Arts Council of Great Britain*. London: The Baynard Press, 1945.

Kitchen, Paddy. *A Most Unsettling Person: The Life and Ideas of Patrick Geddes, Founding Father of City Planning and Environmentalism*. New York: Saturday Review Press, 1975.

Kjeldsen, Peter, Morton A. Barlaz, Alix P. Rooker, Anders Baun, Anna Ledin, and Thomas H. Christensen. “Present and Long-term Composition of MSW Landfill Leachate: A Review.” *Critical Reviews in Science and Technology* 32, no. 4 (2002): 297-336.

Klare, Michael T. *Resource Wars: The New Landscape of Global Conflict*. New York: Metropolitan Books, 2001.

Klein, Jullie T. “Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review.” *American Journal of Preventive Medicine* 35, no. 2 (2008): S116–23.

Krook, Joakim and Leenard Baas. “Getting Serious about Mining the Technosphere: A Review of Recent Landfill Mining and Urban Mining Research.” *Journal of Cleaner Production* 55 (2013): 1-9.

Krook, Joakim, Niclas Svensson, and Mats Eklund. “Landfill Mining: A Critical Review of Two Decades of Research.” *Waste Management* 32 (2012): 513-520.

Kuhn, Thomas S. *The Structure of Scientific Revolutions* 2nd ed. Chicago: The University of Chicago Press, 1970.

Laner, David, Oliver Cencic, Niclas Svensson, and Joakim Krook. “Quantitative Analysis of Critical Factors for the Climate Impact of Landfill Mining.” *Environmental Science & Technology* 50 (2016): 6882-6891.

Lattanzi, M. *Transdisciplinarity: Stimulating Synergies, Integrating Knowledge*. Paris: UNESCO, 1998.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network Theory*. New York, Oxford University Press: 2005.

Law, Alex. “The Ghost of Patrick Geddes: Civics as Applied Sociology.” *Sociological Research Online* 10, no. 2 (2005).

League of Women Voters. *The Garbage Primer: A Handbook for Citizens*. New York: Lyons & Burford, 1993. (a)

League of Women Voters. *The Nuclear Waste Primer: A Handbook for Citizens*. New York: Lyons & Burford, 1993. (b)

League of Women Voters. *The Plastics Primer: A Handbook for Citizens*. New York: Lyons & Burford, 1993. (c)

Lefebvre, Henri. “The Everyday and Everydayness.” *Yale French Studies* 73 (1987): 7-11. Translated by Christine Levich.

———. *Critique of Everyday Life*. Translated by John Moore. London and New York: Verso, 1991.

Lehmann, Steffen. “Resource Recovery and Materials Flow in the City: Zero Waste and Sustainable Consumption as Paradigms in Urban Development.” *Sustainable Development Law & Policy* 11, no. 1 (2010): 28-38.

———. “The Metabolism of the City.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. London and New York: Earthscan, 2012.

Lehmann, Steffen and Robert Crocker. “Introduction: People, Policies and Persuasion: The Future of Waste Reduction and Resource Recovery in Households and Urban Settings.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. London and New York: Earthscan, 2012.

Levitzke, Vaughan. “Foreword: Designing for Zero Waste.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. London and New York: Earthscan, 2012.

Lewis, Peirce K. “Axioms for Reading the Landscape: Some Guides to the American Scene.” In *The Interpretation of Ordinary Landscapes: Geographical Essays*, edited by D. W. Meinig. Oxford: Oxford University Press, 1979.

Long, Robert Emmet, ed. *The Problem of Waste Disposal*. New York: H. W. Wilson, Co., 1989.

Louis, Garrick E. “A Historical Context of Municipal Solid Waste Management in the United States.” *Waste Management & Research* 22 (2004): 306-322.

Lovins, Amory B., L. Hunter Lovins, and Paul Hawken. “A Road Map for Natural Capitalism.” *Harvard Business Review*. May – June (1999): 146-158.

MacBride, Samantha. *Recycling Reconsidered: The Present Failure and Future Promise of Environmental Action in the United States*. Cambridge, MA: MIT Press, 2011.

MacKaye, Benton. *The New Exploration: A Philosophy of Regional Planning*. New York: Harcourt, Brace and Co., 1928.

MacLean, Alair. “Environmental Racism.” In *Environmental Encyclopedia* Vol. 1, 4th ed. Edited by Deirdre S. Blanchfield. Detroit: Gale, 2011. 605-606.

Magoc, Chris J. *Chronology of Americans and the Environment*. Santa Barbara, CA: ABC-CLIO, 2011.

Marella, Giuliano and Roberto Raga. “Use of the Contingent Valuation Method in the Assessment of a Landfill Mining Project.” *Waste Management* 34 (2014): 1199-1205.

Marx, Karl. *Capital: A Critique of Political Economy, Volume I*. Translated by Ben Fowkes. New York: Vintage Books, 1976 [1867].

Marx, Karl. *Capital: A Critique of Political Economy, Volume III: The Process of Capitalist Production as a Whole*. Edited by Frederick Engels. Translated by Ernest Untermann. Chicago: Charles H. Kerr & Co., 1909 [1894].

McChesney, Robert W. *The Political Economy of Media: Enduring Issues, Emerging Dilemmas*. New York: NYU Press, 2008.

McDonough, William. “Design, Ecology, Ethics and the Making of Things.” *Centennial Sermon at St. John the Divine* (lecture). New York, February 7, 1993.

McKendrick, Neil, John Brewer, and J. H. Plumb. *The Birth of a Consumer Society: The Commercialization of Eighteenth-Century England*. Bloomington, IN: Indiana University Press, 1982.

Meller, Helen. *Patrick Geddes: Social Evolutionist and City Planner*. London and New York: Routledge, 1993.

Melosi, Martin V. *Garbage in the Cities: Refuse, Reform, and the Environment, 1880 – 1980*. College Station, TX: Texas A&M University Press, 1981.

———. *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*. Baltimore, MD: The Johns Hopkins University Press, 2000.

———. *Effluent America: Cities, Industry, Energy, and the Environment*. Pittsburgh, PA: University of Pittsburgh Press, 2001.

———. “Full Circle? Public Responsibility Versus Privatization of Water Supplies in the United States.” In *Pragmatic Sustainability: Theoretical and Practical Tools* 1st ed. Edited by Steven A. Moore. New York: Routledge, 2010. 215-232.

———. “Fresh Kills: The Making and Unmaking of a Wastescape.” In *Out of Sight, Out of Mind: The Politics and Culture of Waste*. Edited by Christof Mauch. *RCC Perspectives: Transformations in Environment and Society* 1 (2016): 59-65.

Mohai, Paul and Robin Saha. “Racial Inequality in the Distribution of Hazardous Waste: A National-Level Reassessment.” *Social Problems* 54, no. 3 (2007): 343-370.

Moore, Steven A. *Alternative Routes to the Sustainable City: Austin, Curitiba, and Frankfurt*. Lanham, MD: Lexington Books, 2007.

———. “Knowledge, Education, Power and Production: Public Interest Design in North America.” *Journal of Architectural Education* 71, no. 1 (2017): 46-55.

Moore, Wendy. “So Many, So Wrong.” *British Medical Journal* 334, no. 7588 (Feb 2007): 318.

Müller, Simone M. “The ‘Flying Dutchmen’: Ships’ Tales of Toxic Waste in a Globalized World.” In *Out of Sight, Out of Mind: The Politics and Culture of Waste*. Edited by Christof Mauch. *RCC Perspectives: Transformations in Environment and Society* 1 (2016): 13-19.

Mumford, Lewis. *The Culture of Cities*. New York: Harcourt Brace Jovanovich, 1970 [1938].

Naik, Gautam. “Small Companies Reap Harvest From Food Composting: Entrepreneurial Efforts Aid Stores, Restaurants Via Lower Disposal Costs.” *Wall Street Journal*, Feb. 18, 1993.

National Board of Health, “Report on Sanitary Survey of Memphis, Tenn.” In *Annual Report of the National Board of Health* – 1880. Washington, D.C.: Government Printing Office, 1880): 416-441.

National Recreation and Park Association. “America’s Backyard: Freshkills Park: Staten Island, New York.” In *Parks & Recreation* (November 2011): 80.

Nikolova, Lolita Petrova. “Germ Theory of Disease.” In *Encyclopedia of Consumption and Waste: The Social Science of Garbage*. Thousand Oaks, CA: SAGE, 2012.

Odom, Howard T. *Systems Ecology: An Introduction*. New York: Wiley-Interscience, 1983.

Olmsted, Frederick Law. “Public Parks and the Enlargement of Towns.” In *Civilizing American Cities: Writings on City Landscapes*. Edited by S. B. Sutton. New York: Da Capo Press, 1997.

Orr, David W. *The Nature of Design: Ecology, Culture and Human Intention*. New York: Oxford University Press, 2002.

Pachauri, Rajendra K., Myles R. Allen, Vicente R. Barros, John Broome, Wolfgang Cramer, Renate Christ, John A. Church, et al. *Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change*. IPCC, 2014. Accessed at https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

Peterson, Jon A. "The City Beautiful Movement: Forgotten Origins and Lost Meanings." In *Journal of Urban History* 2, no. 4 (1976): 416-428.

———. "The Impact of Sanitary Reform on American Urban Planning." In *Journal of Social History* 13, no. 1 (1979): 83-103.

Pinjing, He, Lü Fan, Zhang Hua, and Shao Liming. "Recent Developments in the Area of Waste as a Resource, with Particular Reference to the Circular Economy as a Guiding Principle." *Issues in Environmental Science and Technology* 37 (2013): 144-161.

Quaghebeur, Mieke, Ben Laenen, Daneel Geysen, Peter Nielsen, Yiannis Pontikes, Tom Van Gerven, and Jeroen Spooren. "Characterization of Landfilled Materials: Screening of the Enhanced Landfill Mining Potential." *Journal of Cleaner Production* 55 (2013): 72-83.

Rabinovitch, Jonas, and Josef Leitman. "Urban Planning in Curitiba." *Scientific American* 274, no. 3 (1996): 46-53.

Rada, Elena Cristina. "Introduction." In *Waste Management and Valorization: Alternative Technologies*. Edited by Elena Cristina Rada. Waretown, NJ: Apple Academic Press, 2016. xvii-xviii.

Raga, Roberto, Raffaello Cossu, Joern Heerenklage, Alberto Pivato, and Marco Ritzkowski. "Landfill Aeration for Emission Control Before and During Landfill Mining." *Waste Management* 46 (2015): 420-429.

Rathje, William. "Rubbish!" *Atlantic Monthly* 264 (1989): 99-110.

Rathje, William and Cullen Murphy. *Rubbish!: The Archaeology of Garbage*. Tucson, AZ: The University of Arizona Press, 2001.

Rawls, John. *A Theory of Justice*. Cambridge, MA: Belknap Press, 1971.

Reynolds, Terry S. “The Engineer in Nineteenth Century America.” In *The Engineer in America*. Edited by Terry S. Reynolds. Chicago: University of Chicago Press, 1991.

Ringquist, Evan J. “Assessing Evidence of Environmental Inequities: A Meta-Analysis.” *Journal of Policy Analysis and Management* 24, no. 2 (2005): 223-247.

Rittel, Horst W. J. and Melvin M. Webber. “Dilemmas in a General Theory of Planning.” In *Policy Sciences* 4 (1973): 155-169.

Rogers, Everett M. *Diffusion of Innovations*. New York: The Free Press of Glencoe, 1962.
———. "Diffusion Theory." *Encyclopedia of Public Health* Vol. 2. Edited by Lester Breslow. New York: Macmillan Reference USA, 2002. 334-336.

Rogers, Heather. *Gone Tomorrow: The Hidden Life of Garbage*. New York: The New Press, 2006.

———. *Green Gone Wrong: How Our Economy Is Undermining the Environmental Revolution*. New York: Scribner, 2010.

Rosenbloom, Sandra. “Women’s Travel Issues: The Research and Policy Environment.” In *Women’s Travel Issues: Research Needs and Priorities—Conference Proceedings and Papers*. Edited by Sandra Rosenbloom. US Department of Transportation, Research, and Special Programs Administration, January 1978.

Saks, Mike. “Removing the Blinkers? A Critique of Recent Contributions to the Sociology of Professions.” *Sociological Review* 31, no. 1 (1983): 1-21.

———. *Professions and the Public Interest: Medical Power, Altruism and Alternative Medicine*. New York: Routledge, 1995.

———. “Inequalities, Marginality, and the Professions.” *Current Sociological Review* 63, no. 6 (2015): 850-868.

Sandercock, Leonie. “Introduction: Framing Insurgent Historiographies for Planning.” In *Making the Invisible Visible: A Multicultural Planning History*. Edited by Leonie Sandercock. Berkeley, CA: University of California Press, 1998.

Santos-Hernández, Jenniffer M. “Young Lords.” In *Encyclopedia of Race, Ethnicity, and Society*. Edited by Richard T. Schaefer. Thousand Oaks, CA: SAGE, 2008. 1421-1422.

Savage, George M. "Landfill Mining: Past and Present." *Biocycle: 1993* (1993).

Schrab, Gregory Ernst, Kirk W. Brown, and K.C. Donnelly. “Acute and Genetic Toxicity of Municipal Landfill Leachate.” *Water, Air, and Soil Pollution* 69 (1993): 99-112.

Schuessler, Ryan. “St. Louis Burning: A Ticking Time Bomb Beneath the City?” In *Al Jazeera English*, May 1, 2015.

Schultz, Stanley K. and Clay McShane. “To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late-Nineteenth-Century America.” In *Journal of American History* 65, no. 2 (1978): 389-411.

Shabecoff, Philip. “With No Room at the Dump, U.S. Faces Garbage Crisis.” *New York Times*, June 29, 1987. Accessed at http://www.nytimes.com/1987/06/29/us/with-no-room-at-the-dump-us-faces-a-garbage-crisis.html?mcubz=1.

Simon, Herbert. “The Science of Design: Creating the Artificial.” *Design Issues* 4, no. 1-2 (1988): Cambridge, MA: The MIT Press, 1988.

Skog, Kenneth E., Peter J. Ince, and Richard W. Haynes. “Wood Fiber Supply and Demand in the United States.” In *Proceedings of the Forest Products Study Group Workshop*. Available online at https://www.fpl.fs.fed.us/documnts/pdf1998/skog98b.pdf.

Small, William E. *Third Pollution: The National Problem of Solid Waste Disposal*. New York: Praeger, 1970.

Smith, Adam. *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell, 1776.

Snyder, Mary Gail. “Feminist Theory and Planning Theory: Lessons from Feminist Epistemologies.” *Berkeley Planning Journal* 10, no. 1 (1995): 92-106.

Sonnenberg, Frank A. and C. Gregory Hagerty. “Decision Trees, Construction.” In *Encyclopedia of Medical Decision Making*. Thousand Oaks, CA: SAGE, 2009. 333-338.

Stanley, Jason. "The Emergency Manager: Strategic Racism, Technocracy, and the Poisoning of Flint's Children." *The Good Society* 25, no. 1 (2017): 1-45.

Tabb, William K. “Resource Wars.” *Monthly Review* 58, no. 8 (2007): 32-42.

Taylor, Dorceta E. *Toxic Communities: Environmental Racism, Industrial Pollution, and Residential Mobility*. New York: New York University Press, 2014.

Tierney, John. “Recycling is Garbage.” In *New York Times*, New York, June 30, 1996.

Tretter, Eliot M. “Austin Restricted: Progressivism, Zoning, Private Racial Covenants, and the Making of a Segregated City.” Final Report for the Institute for Urban Policy Research and Analysis, 2012.

Trumpeter, Kevin. “Fresh Kills Landfill.” In *Encyclopedia of Consumption and Waste: The Social Science of Garbage*. Edited by Carl A. Zimring and William L. Rathje. Thousand Oaks, CA: SAGE, 2012. 280-281.

Tversky, Amos, and Daniel Kahneman. "The Framing of Decisions and the Psychology of Choice." *Science* 211, no. 4481 (1981): 453-58.

Unruh, Gregory C. “Understanding Carbon Lock-in.” *Energy Policy* 28 (2000): 817-830.

van Haaren, Rob, Nickolas Themelis, and Nora Goldstein. “The State of Garbage in America.” *Biocycle*. October 2010.

Van Passel, Steven, Maarten Dubois, Johan Eyckmans, Serge de Gheldere, Frederic Ang, Peter Tom Jones, and Karel Van Acker. “The Economics of Enhanced Landfill Mining: Private and Societal Performance Drivers.” *Journal of Cleaner Production* 55 (2013): 92-102.

van der Zee, D. J., M. C. Achterkamp, and B. J. de Visser. “Assessing the Market Opportunities of Landfill Mining.” *Waste Management* 24 (2004): 795-804.

Vannini, Phillip. “Critical Pragmatism.” In *The SAGE Encyclopedia of Qualitative Research Methods.* Edited by Lisa M. Given. Thousand Oaks, CA: SAGE, 2008.

Vogt, W. Paul. “Snowball Sampling.” *Dictionary of Statistics & Methodology* 4th ed. Thousand Oaks, CA: SAGE, 2011. 368.

Wagland, Stuart. “Treasure Island.” *Chartered Institute of Wastes Management* (2016): 36-37.

Wagner, Travis and Tom Raymond. “Landfill Mining: Case Study of a Successful Metals Recovery Project.” *Waste Management* 45 (2015): 448-457.

Walker, Alexander. “Life-cycle Thinking, Analysis, and Design.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. London and New York: Earthscan, 2012.

Waring, Jr., George E. *Modern Methods of Sewage Disposal for Towns, Public Institutions, and Isolated Houses*. New York: D. Van Nostrand Co., 1894.

Welter, Volker M. *Biopolis: Patrick Geddes and the City of Life*. Cambridge, MA: MIT Press, 2002.

Whalen, Carmen Teresa. “Young Lords (1968–1972).” In *Latinas in the United States: A Historical Encyclopedia* Vol. 3. Edited by Vicki L. Ruiz and Virginia Sanchez Korrol. Bloomington, IN: Indiana University Press, 2006. 815-817.

Wilson, Lou. “Planning for the Sustainable Consumption of Urban Resources.” In *Designing for Zero Waste: Consumption, Technologies and the Built Environment*. Edited by Steffen Lehmann and Robert Crocker. London and New York: Earthscan, 2012.

Wilson, William H. *The City Beautiful Movement*. Baltimore, MD: Johns Hopkins University Press, 1989.

Wolman, Abel. "The Metabolism of Cities." *Scientific American* 213, no. 3 (1965): 179-190.

World Bank. “Waste Not, Want Not – Solid Waste at the Heart of Sustainable Development.” *World Bank*. March 3, 2016. Accessed at http://www.worldbank.org/en/news/feature/2016/03/03/waste-not-want-not---solid-waste-at-the-heart-of-sustainable-development.

Yearly, Steven. “Social Studies of Science and Technology.” In *Encyclopedia of Philosophy and the Social Sciences*. Edited by Byron Kaldis. Thousand Oaks, CA: SAGE, 2013. 934-939.

Yin, Robert K. *Case Study Research: Design and Methods* 4th ed. Thousand Oaks, CA: SAGE, 2009.

Young, Robert F. “’Free Cities and Regions:” Patrick Geddes’s Theory of Planning.” In *Landscape and Urban Planning* 166 (2017): 27-36.

Zero Waste International Alliance. “ZW Definition.” *Zero Waste International Alliance* (website), 2009. Accessed at http://zwia.org/standards/zw-definition/.

Zhou, Chuanbin, Wenjun Fang, Wanying Xu, Aixin Cao, and Rusong Wang. “Characteristics and the Recovery Potential of Plastic Wastes Obtained from Landfill Mining.” *Journal of Cleaner Production* 80 (2014): 80-86.

Zhou, Chuanbin, Zhe Gong, Junsong Hu, Aixin Cao, and Hanwen Liang. “A Cost-Benefit Analysis of Landfill Mining and Material Recycling in China.” *Waste Management* 35 (2015): 191-198.

Ziffren, Abbie. “Biography of Patrick Geddes.” In *Patrick Geddes: Spokesman for Man and the Environment*. Edited and introduced by Marshall Stalley. New Brunswick, NJ: Rutgers University Press, 1972.

Zimring, Carl A. “George Waring.” In *Encyclopedia of Consumption and Waste: The Social Science of Garbage*. Edited by Carl A. Zimring and William L. Rathje. Thousand Oaks, CA: SAGE, 2012.